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ABSTRACT

This curriculum guide is intended to assist vocational instructors in preparing students for entry-level employment as welders and preparing them for advanced training in the workplace. The package contains an overview of new and emerging welding technologies, a competency/skill and task list, an instructor's guide, and an annotated bibliography. The following competencies are covered: using oxyfuel equipment to flame-cut in specified positions, using oxyacetylene equipment to produce specified welds, using oxyacetylene equipment to produce specified brazed joints, using alternating (AC) or direct current (DC) shielded metal arc welding equipment to produce specified welds, using AC or DC arc cutting equipment to produce specified cuts, using gas metal arc and gas tungsten arc equipment to produce specified welds, performing hardfacing and build-up procedures, reading and drawing shop prints, and estimating project cost and time requirements. The instructor's guide consists of a series of task sheets, each of which includes some or all of the following: competency/skill statement; task statement; performance objectives (including conditions in which the task is to be performed, evaluation criteria, and an evaluation standard); suggested student learning experiences; recommended instructional techniques; instructional equipment, materials, and supplies needed to complete the lesson; and recommended resources. (MN)

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WELDING

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WELDING

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FOREWORD

An essential element of any curriculum is a validated task list. Vocational welding instructors need a well developed task list to provide the basis for a course of study and to make possible communication and articulation with other instructors and institutions in the area.

The task list in this guide was validated for content accuracy and completeness using detailed job/task analysis approaches and methods. A group of recognized content experts from each specialty area in the field of welding, representing vocational instruction and industry, were called upon to develop and validate the task list. Validation of the curriculum guide was accomplished by the review of sections of the guide by additional representatives of industry and vocational instruction.

Validated competencies have been utilized in curriculum design by both the Arizona Department of Education and the Community Colleges in Arizona. This task list represents a major effort on the part of both agencies to compile the lists of competencies into one list. Articulation between secondary and post secondary programs will be facilitated by having all of the validated competencies for welding on one list.

During the process of developing this guide, competencies and tasks were changed or combined to enhance clarity, readability and continuity. The competencies and tasks were edited and arranged to provide a logical sequence and order. In this process, no competencies or tasks were omitted.

The format of the guide provides for individual student or instructor use. The instructor can duplicate pages or sections of the guide to include COMPETENCIES; TASKS; PERFORMANCE OBJECTIVES; STUDENT LEARNING EXPERIENCES; SUGGESTED INSTRUCTIONAL TECHNIQUES; INSTRUCTIONAL MATERIALS, EQUIPMENT AND SUPPLIES; and RESOURCES in a course outline.

The major emphasis of the Welding Instructors Guide is welding skill development; however, considerable emphasis is placed on related academics, planning and problem solving. Welders will need reading, math, and communication skills, as well as the ability to plan and solve problems in order to advance or even survive in a changing industry.

A new feature of this guide is the addition of a section on New and Emerging Welding Technology and Processes. Today's vocational welding student will enter a job market where the only sure thing is change. A student who has an awareness of the latest developments in welding technology and a willingness to explore new things will have a competitive edge.

ACKNOWLEDGEMENTS

The Welding Competency Based Curriculum Guide is the result of many people working together to insure quality programs for young people seeking education and training in the field of welding.

A committee made up of secondary and post secondary welding instructors was assigned the responsibility of editing and combining the validated task lists of the Arizona State Department of Education and the Community colleges of Arizona. For their commendable efforts in time and expertise spent in producing the articulated task list, recognition is given to:

The articulated task list was developed into the Welding Instructors Guide by:

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WELDING COMPETENCIES

1.0 Uses Oxyfuel Equipment to Flame-Cut in Specified Positions

- 1.1 Cuts steel using hand operated oxyfuel cutting equipment.
- 1.2 Uses the mechanical straight-line track torch.
- 1.3 Cuts shapes using the mechanical pattern torch.
- 1.4 Cuts and bevels pipe with manual and semi-automatic cutting apparatus.

2.0 Uses Oxyacetylene Equipment to Produce Specified Welds

- 2.1 Welds a flat puddling bead.
- 2.2 Welds butt joints.
- 2.3 Welds lap joints.
- 2.4 Welds "T" joints.
- 2.5 Welds outside corner joints.
- 2.6 Welds pipe in the 2G, 5G and 6G fixed positions.

3.0 Uses Oxyacetylene Equipment to Produce Specified Brazed Joints

- 3.1 Cleans joint area.
- 3.2 Brazes a butt joint.
- 3.3 Brazes a lap joint.
- 3.4 Brazes an outside corner joint.
- 3.5 Brazes a "T" joint.
- 3.6 Brazes a cast iron butt joint.

4.0 Uses AC or DC Shielded Metal Arc Welding (SMAW) Equipment to Produce Specified Welds.

4.1 Welds pads, butt, lap, "T", and "V" joints in the flat position.

4.2 Welds pads, butt, lap, "T", and "V" joints in the horizontal position.

4.3 Welds pads, butt, lap, "T", and "V" joints in the vertical position.

4.4 Welds pads, butt, lap, "T", and "V" joints in the overhead position.

4.5 Welds pipe in the 2G position.

4.6 Welds pipe in the 5G position.

4.7 Welds pipe in the 6G position.

5.0 Uses AC or DC Arc Cutting Equipment to Produce Specified Cuts.

5.1 Uses Shielded Metal-Arc Cutting (S.M.A.C.) equipment.

5.2 Uses Carbon-Arc Cutting (C.A.C.) equipment.

5.3 Uses Air Carbon-Arc Cutting (A.C.A.C.) equipment.

5.4 Uses Plasma-Arc Cutting (P.A.C.) equipment.

6.0 Uses Gas Metal Arc Welding (GMAW) Equipment to Produce Specified Welds

6.1 Welds flat position beads, butt joints, lap joints, "T" joints and "V" groove joints.

6.2 Welds horizontal position beads, butt joints, lap joints, "T" joints and "V" groove joints.

6.3 Welds vertical position beads, butt joints, lap joints, "T" joints and "V" groove joints

6.4 Welds overhead position beads, butt joints, lap joints, "T" joints and "V" groove joints

7.0 Uses Gas Tungsten Arc (GTAW) Equipment to Produce Specified Welds

7.1 Welds flat position beads, butt joints, lap joints, "T" joints and "V" groove joints

7.2 Welds horizontal position beads, butt joints, lap joints, "T" joints and "V" groove joints.

7.3 Welds vertical position beads, butt joints, lap joints, "T" joints and "V" groove joints

7.4 Welds overhead position beads, butt joints, lap joints, "T" joints and "V" groove joints

8.0 Performs Hardfacing & Build-Up Procedures.

8.1 Builds up worn or damaged base metal to original specifications.

8.2 Applies hardfacing materials to metal surfaces.

9.0 Reads, Interprets and Draws Shop Prints.

9.1 Identifies and interprets welding symbols and standard notes from drawings and sketches.

9.2 Reads and interprets shop prints and sketches.

9.3 Sketches pictorial views from orthographic views.

9.4 Constructs solid geometric shapes.

9.5 Draws sketches of existing objects.

9.6 Produces a set of working drawings.

10.0 Estimates Project Cost and Time Requirements.

10.1 Analyzes drawings to determine scope of work.

10.2 Produces a complete list of materials.

10.3 Prepares a cutting list.

10.4 Determines fabrication time requirements.

10.5 Determines labor cost.

10.6 Determines material cost.

10.7 Prepares a written estimate.

10.8 Presents a written proposal to client.

NEW AND EMERGING WELDING TECHNOLOGIES AND PROCESSES

The major emphasis of this guide is welding skill development; however if students are to be successful in the future, they will have to gain new skills and adapt to new technologies and processes.

The purpose of this unit is to introduce the student to new and emerging processes. No attempt is made to suggest practical experience or skill development in these areas, rather an awareness of their existence is sought.

SUBMERGED ARC WELDING (SAW)

Many of the emerging processes are not new by any stretch of the imagination. Lets look at submerged arc welding (SAW) as an example. This process has been in use for many years, but it has only recently come into its own as a widely used method of welding.

SAW welding has some advantages which include, high quality welds, no splatter, no visible arc, and very high deposition rates. Larger SAW machines can produce single pass butt welds on material up to 3" in thickness. The larger machines can weld with current up to 4000 amps and use up to 1/2" diameter electrodes.

The SAW process can be set up for either manual or semi-automatic operation. In either mode, SAW is similar to GMAW in equipment and technique used.

FLUX CORED ARC WELDING (FCAW)

A process that is similar to gas metal arc welding (GMAW), which has gained popularity in recent years is flux cored arc welding (FCAW). In this type of welding a hollow electrode wire carries its own flux inside the core. The shielding of the weld bead is accomplished by the gaseous envelope produced by the flux core. This type of electrode wire operates much like a SMAW coated electrode except that the flux is on the inside of the wire rather than on the outside. FCAW offers the benefits of high deposition rates, the ability to weld continuously for long periods, a thin layer of slag which allows the weld to cool slowly, and metallurgical effects which can be controlled by using various fluxing and alloying agents in the core of the wire. A combination of the GMAW and FCAW processes results in flux cored arc welding-gas shielded, (FCAW-GS).

FLUX CORED ARC WELDING-GAS SHIELDED (FCAW-GS)

This process is essentially a combination of the best of the FCAW and GMAW systems. A flux or alloy cored wire is used in combination with a shielding gas to produce characteristics which would be difficult or impossible to attain by using the methods separately. As with the above processes, FCAW-GS can be set up to operate manually or semi-automatically.

PLASMA ARC WELDING (PAW)

Another welding process that can be used either manually or semi-automatically is plasma arc welding (PAW). The preferred method of operation is semi-automatic because of higher welding speeds and higher quality welds. Advantages of PAW include concentrated current flow, arc stability with large variations in arc length, low heat input, and high welding speeds. Plasma arc cutting (PAC) may also be done with the same type equipment as PAW. PAC will cut almost all metals efficiently, quickly, and cleanly.

ELECTRON BEAM WELDING (EBW)

The electron beam welding (EBW) process is done automatically after set up because the part to be welded must be moved precisely under the beam on some sort of carriage in order for the weld to be completed satisfactorily. EBW can be done at atmospheric pressure, in a partial vacuum, or in a high vacuum. The best quality welds are done in a high vacuum, but they are also the most expensive to produce. The weld produced is narrow in cross section and the metal to be joined must be very straight on its mating faces as the beam is extremely narrow. EBW achieves excellent penetration and very high welding speeds, but cost per weldment is high and equipment is expensive.

LASER BEAM WELDING (LBW)

Laser beam welding (LBW) is similar to EBW in the way the joint faces are prepared and set up. This process need not be in a vacuum to produce high quality welds. The energy of focused, coherent light is used to produce a high energy density welding, cutting (drilling), or heat treating process. LBW employs a shielding gas to protect the weld zone from oxidation. Although laser welders are not as powerful as EBWs, the higher powered types can produce full penetration welds in 3/4" thick steel at high welding speeds.

EXPLOSION WELDING (EXW)

Speaking of high welding speeds, the explosion welding (EXW) process happens almost instantaneously! The metals to be welded are placed at an angle to each other, something like a partially opened book. A protective material is placed over the outside surfaces of the metal and the explosives are placed on top of that. Take cover! The explosives are detonated and the resulting force slams the metal plates together at such high velocity that the mating surfaces ripple as they come together. These ripples lock or weld the plates together. One big advantage of this process is that it allows you to join unlike as well as like metals successfully and quickly.

ULTRASONIC WELDING (USW)

Ultrasonic welding (USW) is somewhat similar to EXW in that fusion of the metal-to-metal joint does not occur in the welding process. In USW, the metals to be welded are clamped together under pressure and they are vibrated at frequencies between 10,000 and 75,000 Hz. The rapid movement between the metal surfaces breaks up the surface films and causes the solid metals to bond tightly together without the use of heat and without melting the metal.

Since the metal is not heated, there is no heat distortion. Fluxes and filler metals are not needed, and thin materials can be easily welded to thicker materials. The process can be used to join like or unlike metals and the equipment can be operated by semi-skilled personnel after only a short training period.

TORCH PLASTIC WELDING

There are two groups of plastics materials. One is the thermosetting group which cannot be reheated and reformed once cooled, and therefore cannot be welded. The group which can be welded is the thermoplastic group. These plastics can be reheated and softened any number of times.

The thermoplastics are welded in much the same manner as steel. The same positions and joint designs that are used for steel are also used for plastics welding. The welding rod for plastics must be of the same composition as the material being welded.

The heat required to complete the plastics welding process is supplied by either heated compressed air or heated shielding gas. No flame comes in contact with the joint. The welding is done much like oxyfuel or GTAW as the torch is manipulated by one hand and the filler rod by the other. The process can, of course, be performed by automatic or robotic means.

While we have listed several processes which have been on the welding scene for a number of years, there are significant changes that have come about recently, and more changes are happening even as this is written.

ROBOTICS AND AUTOMATIC WELDING

According to the American Welding Society automatic welding is: "Welding with equipment which performs the welding operation without adjustment of the controls by a welding operator. The equipment may or may not perform the loading and unloading of the work."

Although a welding operator (Weldor) is not needed while the process is occurring, a highly skilled Weldor must select the parameters to be followed for the automatic welding operation(s) to be completed successfully. These parameters could include, but not be limited to: voltage, current, electrode alloy and diameter, wire feed speed, travel speed, shielding gas, burn back rate, crater fill time, pulse rate, and slopes to name a few.

Robots are defined by The Robot Institute of America as "A reprogammable, multifunctional manipulator, designed to move material, parts, tools, or specialized devices, through variable programmed motions to accomplish a variety of tasks." By combining the capabilities of automatic welding systems with robots, tremendous advantages are realized. By electronically monitoring the welding process with feedback controls and by coupling the welding or cutting heads to a robot, productivity can be increased, quality can be improved, and costs can be reduced.

Automatic welding (as well as conventional welding) processes have been greatly improved in the last few years by the use of solid state controls and components built into the power sources, feeders, and control circuits. The use of SCRs, transistors, etc., has made possible the complete control of the welding cycle to a degree which was not practical before their development and use.

Some of the welding equipment in use today utilizes enough solid state electronic circuitry to be compared to powerful computers.

As the need for higher production rates with better quality and lower costs becomes essential in order for industry to remain competitive, new and improved equipment techniques, and processes must continue to be developed and used.

It is imperative that any weldor who wishes to advance in his/her chosen field must be able to recognize and effectively deal with changes in the industry.

1.0 **COMPETENCY/SKILL:** Uses oxyfuel equipment to flame-cut specified positions.

1.1 **TASK:** Cuts steel using hand operated oxyfuel cutting equipment.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyfuel cutting equipment and various thicknesses of mild steel plate,

EVALUATION: cuts steel using hand operated oxyfuel cutting equipment.

STANDARD: Evidence of correct travel speed, pre-heat, coupling distance, and oxygen-to-fuel gas ratio will be determined by evaluating the appearance and accuracy of the finished cuts.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for oxyfuel cutting equipment.
2. Practice setting up and adjusting the oxyfuel cutting equipment.
3. Measure and mark plates to the specified sizes.
4. Make a series of practice cuts in four positions.
5. Compare the practice cuts to a sample set of standard oxyfuel cut plates.
6. Analyze practice cuts for incorrect technique and correct any deficiencies.
7. Flame cut a series of twelve test plates for final evaluation.
8. Shut down the cutting equipment.
9. Evaluate a set of flame cut samples, list and explain the defects in each sample.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate assembly and adjustment of oxyfuel cutting equipment.

2. Discuss and demonstrate correct oxyfuel cutting procedures to the whole class.

3. Assign students to small groups or teams to rotate through oxyfuel cutting processes.

4. Prepare a set of sample standard oxyfuel cut plates to provide a basis for student comparison and evaluation of their work.

5. Assign advanced level students to prepare and present a small group lecture/demonstration of the oxyfuel hand cutting torch.

6. Help individual students to correctly use the oxyfuel hand cutting torch.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyfuel cutting sets.

2. Soapstone, straight edge, tape rule, striker, tip cleaner, chipping hammer, and pliers.

3. Student sets of personal welding protective equipment.

4. Various thicknesses of mild steel plate.

5. Set of hand flame cut example plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland IL. pp. 147-152. 1984.

Jeffus, Larry and Harold Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 141-164. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Company, Inc. Encino, CA. pp. 271-296. 1982.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co. Novato, CA. pp. 99-130. 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 459-470. 1978.

Booklets;

OPERATORS MANUAL FOR OXYFUEL GAS CUTTING. 28 pp. American Welding Society. Miami, FL. 1978.

Videos;

THE OTHER HALF OF THE SAFETY TEAM VHS (SAFETY) Agency for Instructional Technology, Bloomington, IN.

Computer Programs;

WELDING MATERIALS SAFETY AND OPERATIONS, Career Aids Inc., Chatsworth, CA. 1987.

1.0 **COMPETENCY/SKILL:** Uses oxyfuel equipment to flame-cut specified positions.

1.2 **TASK:** Uses the mechanical straight-line track torch.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyfuel cutting equipment, a mechanical straight-line track torch and various thicknesses of mild steel plate,

EVALUATION: uses the mechanical straight-line track torch.

STANDARD: Evidence of straightness of cut, correct travel speed, pre-heat, coupling distance, and oxygen-to-fuel gas ratio will be determined by evaluating the appearance and accuracy of the finished cuts.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for oxyfuel cutting equipment.
2. Correctly identify and list the functions of the parts of the mechanical straight-line cutting torch.
3. List the steps necessary for setting up and adjusting the straight-line cutting torch.
4. List and explain the industrial applications for the straight-line cutting torch.
5. List and explain the safety rules for using the straight-line cutting torch.
6. Measure and mark stock to specified size.
7. Set up, clean, adjust and use the straight-line cutting torch to make practice cuts at 30 and 90 degree angles.
8. Compare practice cuts to a set of standard oxyfuel machine cut sample plates.
9. Analyze practice cuts for proper technique and correct any deficiencies.
10. Produce cuts for evaluation at 90 degrees and 30 degrees and turn in for evaluation.
11. Shut down the straight-line cutting equipment.
12. Evaluate a set of oxyfuel machine cut samples, list and explain the defects in each sample.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate set up and adjustment of the mechanical straight-line track torch.

2. Show film on industrial oxyfuel cutting equipment and techniques.

3. Prepare a set of sample oxyfuel machine cut standard plates to provide a basis for student comparison and evaluation of their work.

4. Assign advanced level students to prepare and present a lecture/demonstration of the mechanical straight-line track torch to small groups.

5. Help individual students to correctly use the mechanical straight-line track torch.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyfuel equipment including, mechanical straight-line track torch(s).

2. Soapstone, tape rule, striker, tip cleaner, chipping hammer and pliers.

3. Student sets of personal welding protective equipment.

4. Various thicknesses of mild steel plate.

5. Set of example oxyfuel machine cut plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland IL. pp. 151-1536. 1984.

Jeffus, Larry and Harold Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. p. 144. 1984.

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Kearns, W.H., WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 470-498. 1978.

Computer Programs;

WELDING MATERIALS SAFETY AND OPERATIONS, Career Aids Inc., Chatsworth, Ca 1987.

Video;

NOISE? YOU'RE IN CONTROL, VHS (SAFETY) Agency for Instructional Technology, Bloomington, IN.

1.0 **COMPETENCY/SKILL:** Uses oxyfuel equipment to flame-cut in specified positions.

1.3 **TASK:** Cuts shapes using the mechanical pattern torch.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyfuel cutting equipment and various thicknesses of mild steel plate,

EVALUATION: cuts shapes using the mechanical pattern torch.

STANDARD: Evidence of correct travel speed, pre-heat, coupling distance, and oxygen-to-fuel gas ratio will be determined by evaluating the appearance and accuracy of the finished cuts.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for oxyfuel cutting equipment.
2. Name the parts of the oxyfuel mechanical pattern torch and describe the function and method of adjustment of each component.
3. List design considerations for different patterns.
4. Evaluate a set of flame cut samples, list and explain the defects in each sample.
5. List and explain the industrial applications for the mechanical pattern torch.
6. List and follow the safety rules for the mechanical pattern torch.
7. Design, draw, and produce a pattern which you will then use to cut a sample part on the mechanical pattern torch.
8. Set-up, clean, adjust, and use the mechanical pattern torch to make practice cuts.
9. Compare practice cuts to a standard mechanical pattern torch cut sample.
10. Analyze practice cuts for incorrect technique and correct any deficiencies.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate proper set up and adjustment of the mechanical pattern torch to the whole class.

2. Display and discuss a variety of pattern-cut samples.

3. Prepare a set of sample pattern-cut plates to provide a basis for student comparison and evaluation of their work.

4. Assign advanced level students to prepare and present a lecture/demonstration of the mechanical pattern torch to small groups.

5. Assign students to small groups or teams to rotate through pattern cutting processes.

6. Help individual students to correctly use the mechanical pattern torch.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyfuel mechanical pattern torch cutting set(s).

2. Tape rule, striker, tip cleaner, chipping hammer, and pliers.

3. Pattern making equipment and supplies

4. Student sets of personal welding protective equipment.

5. Various thicknesses of mild steel plate.

6. Set of example mechanical pattern torch cuts.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland IL. pp. 11 and 173, 151-156. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc. Encino, CA. pp. 181-182. 1984.

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WELDING MATERIALS SAFETY AND OPERATIONS, Career Aids Inc., Chatsworth, CA. 1987.

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THE FUTURE IS IN YOUR HANDS, VHS (Safety) Agency for Instructional Technology, Bloomington, IN.

SUPERWELDER VHS (Safety) Agency for Instructional Technology, Bloomington, IN.

1.0 **COMPETENCY/SKILL:** Uses oxyfuel equipment to flame-cut in specified positions.

1.4 **TASK:** Cuts and bevels pipe with manual and semi-automatic oxyfuel cutting apparatus.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyfuel cutting equipment and various diameters of steel pipe,

EVALUATION: cuts and bevels pipe with manual and semi-automatic cutting apparatus.

STANDARD: Evidence of correct travel speed, pre-heat, coupling distance, and oxygen-to-fuel gas ratio will be determined by evaluating the appearance and accuracy of the finished cuts.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for oxyfuel cutting equipment.
2. Name the parts of the oxyfuel machine pipe cutting torch and describe the function and method of adjustment of each component.
3. Name the parts of the oxyfuel machine pipe cutting torch and describe the function and method of adjustment of each component.
4. Learn and apply the safety rules for the machine pipe cutting torch.
5. Evaluate a set of hand and machine flame cut pipe joints, list and explain the defects in each sample.
6. Set-up, clean, adjust, and use the hand and machine pipe cutting torch to make practice cuts.
7. Compare practice cuts to a standard sample.
8. Analyze practice cuts for incorrect technique and correct any deficiencies.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate proper set up and adjustment of the hand and mechanical pipe cutting torch to the whole class.

2. Display and discuss a variety of hand and mechanically cut pipe samples.

3. Prepare a set of hand and machine cut pipe samples to provide a basis for student comparison and evaluation of their work.

4. Assign students to small groups or teams to rotate through hand and machine pipe cutting processes.

5. Help individual students to correctly use the hand and mechanical pipe cutting torch.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyfuel hand and machine pipe cutting torch set(s).

2. Tape rule, striker, tip cleaner, chipping hammer, wire brush, and pliers.

3. Student sets of personal welding protective equipment.

4. Various diameters of steel pipe.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 170, 514-520. 1984.

Jeffus, Larry and Johnson, Harold WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 141-164. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc. Encino, CA. pp. 230-234. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co. Novato, CA. pp. 364-406. 1984.

Computer Programs;

WELDING MATERIALS SAFETY AND OPERATIONS, Career Aids Inc., Chatsworth, Ca 1987.

2.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified welds.

2.1 **TASK:** Welds a flat puddling bead.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment and various thicknesses of mild steel sheet and plate,

EVALUATION: welds a flat puddling bead.

STANDARD: Finished beads will include correct travel speed, width of the bead, torch distance, gas mixture, penetration, and correct bead layout.

STUDENT LEARNING EXPERIENCES:

1. Write a description of the process of acetylene and oxygen gas production.
2. Explain the physical process of gas fusion welding.
3. Describe the industrial or job applications of gas welding.
4. List six jobs in industry requiring gas welding skills.
5. Correctly name and list the functions of the parts of the oxyacetylene welding set.
6. List, explain, and apply the safety rules and procedures for oxyacetylene welding equipment.
7. Practice setting up, adjusting, lighting and shutting down the oxyacetylene welding set.
8. Identify and explain the characteristics of carburizing, oxydizing, and neutral flames.
9. Measure and mark plates to the specified sizes.
10. Run a series of practice puddling beads in the flat position.
11. Compare the practice beads to a sample set of standard plates.
12. Analyze practice beads for incorrect technique and correct any deficiencies.
13. Produce a set of puddling beads in the flat position for final evaluation.
14. Evaluate a set of flat position puddling beads. List and explain the defects in each sample.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate and explain assembly and adjustment of oxyacetylene welding equipment to the whole class.

2. Discuss oxyacetylene welding processes. Relate learning activities to industrial/job applications.

3. Demonstrate puddling techniques to small groups.

4. Assign advanced level students to prepare and present a small group demonstration of puddling techniques.

5. Prepare a set of sample standard plates to provide a basis for student comparison and evaluation of their own work.

6. Help individual students to develop correct puddling techniques.

7. Show film/video on oxyacetylene welding techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding set(s).

2. Soapstone, straight edge, tape rule, striker, tip cleaner, wire brush, and pliers.

3. Student sets of personal welding protective equipment.

4. Various thicknesses of mild steel sheet and plate.

5. Set of example plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 8, 114-127 and 147-156. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 53-140. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Company, Inc., Encino, CA. pp. 170-22. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc., Encino, CA. pp. 161-175. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co. Novato, CA. pp. 25-95 and 206-21. 1984.

Kearns, W. H., WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 331-367. 1978. (Classic).

Computer Programs;
WELDING EQUIPMENT SAFETY AND OPERATIONS, Career Aids Inc., Chatsworth, CA. 1987.

Filmstrip;
INTRODUCTION TO OXYACETYLENE WELDING, 15 min. Meridian Education Corporation, Blooming IL. 1986.

Video;
OXYACETYLENE WELDING SAFETY Parts 1 and 2. VHS, Abraxas Basic Courseware Eugene, OR.

OXYACETYLENE EQUIPMENT SET-UP AND SAFETY, VHS, Career Aids Inc., Chatsworth, CA.

OXYACETYLENE WELDING VHS, Career Aids Inc., Chatsworth, CA.

WELDING, MAKING IT HAPPEN, VHS, Beta and 3/4", American Welding Society, Miami, FL.

2.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified welds.

2.2 **TASK:** Welds butt joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment and various thicknesses of mild steel sheet and plate,

EVALUATION: welds butt joints.

STANDARD: The finished beads will include correct travel speed, width and height of the bead, torch distance and angle, gas mixture, penetration, and minimum overlap or undercut.

STUDENT LEARNING EXPERIENCES:

1. Measure and mark plates to the specified sizes.
2. Run a series of practice butt welds in the flat, horizontal, vertical and overhead positions.
3. Compare the practice butt welds to a sample set of standard plates.
4. Analyze practice butt welds for incorrect technique and correct any deficiencies.
5. Produce a series of butt welds for evaluation in the flat, horizontal, vertical and overhead positions.
6. Evaluate a set of butt welds. List and explain the defects in each sample.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain purpose and process of butt welding to the whole class. List examples of job applications for butt welding process.
2. Demonstrate butt welding techniques to small groups.
3. Assign advanced level students to prepare and present a small group demonstration of butt welding techniques.
4. Prepare a set of sample standard plates to provide a basis for student comparison and evaluation of their own work.
5. Help individual students to correctly produce butt welds.
6. Show film/video on oxyacetylene welding techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding sets.

2. Soapstone, welding filler rod, straight edge, tape rule, striker, wire brush, tip cleaner, and pliers.

3. Student sets of personal welding protective equipment.

4. Various thicknesses of mild steel sheet and plate.

5. Set of example butt weld plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 8, 114-131 and 147-156. 1984.

Jeffus, Larry and Harold V. Johnson, WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 53-440. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Company, Inc., Encino, CA. pp. 223-246. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc., Encino, CA. pp. 161-175. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co. Novato, CA. pp. 206-220. 1984.

Video;

SQUARE BUTT JOINT FILLER ROD, VHS (OA) Career Aids Inc., Chatsworth, CA.

2.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified welds.

2.3 **TASK:** Welds lap joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment and various thicknesses of mild steel sheet and plate,

EVALUATION: welds lap joints.

STANDARD: The finished beads will include correct travel speed, width and height of the bead, torch distance and angle, gas mixture, and minimum overlap or undercut.

STUDENT LEARNING EXPERIENCES:

1. Measure and mark plates to the specified sizes.
2. Run a series of practice lap welds in the flat, horizontal, vertical and overhead positions.
3. Compare the practice lap welds to a sample set of standard plates.
4. Analyze practice lap welds for incorrect technique and correct any deficiencies.
5. Produce a series of lap welds for evaluation in the flat, horizontal, vertical and overhead positions.
6. Evaluate a set of butt welds. List and explain the defects in each sample.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain purpose and process of lap welding to the whole class. List examples of job applications for butt welding process.
2. Demonstrate lap welding techniques to small groups.
3. Assign advanced level students to prepare and present a small group demonstration of lap welding techniques.
4. Prepare a set of sample standard plates to provide a basis for student comparison and evaluation of their work.
5. Help individual students to develop correct welding techniques.
6. Show film/video on oxyacetylene welding techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding sets.

2. Soapstone, welding filler rod, straight edge, tape rule, striker, wire brush, tip cleaner, and pliers.

3. Student sets of personal welding protective equipment.

4. Various thicknesses of mild steel sheet and plate.

5. Set of example plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc., South Holland, IL. pp. 8, 115-145. 1984.

Jeffus, Larry and Harold V. Johnson, WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 83-140. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Company, Inc., Encino, CA. pp. 234. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc., Encino, CA. pp. 161-175. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co., Novato, CA. pp. 206-217. 1984.

Video;

LAP WELD, VHS (OA) Career Aids Inc., Chatsworth, CA.

2.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified welds.

2.4 **TASK:** Welds "T" joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment and various thicknesses of mild steel sheet and plate,

EVALUATION: welds "T" joints.

STANDARD: The finished beads will include the correct angle of joints, travel speed, width and height of the bead, torch distance and angle, gas mixture, and minimum overlap or undercut.

STUDENT LEARNING EXPERIENCES:

1. Measure and mark plates to the specified sizes.
2. Run a series of practice "T" joint welds in the flat, horizontal, vertical and overhead positions.
3. Compare the practice "T" joints to a sample set of standard plates.
4. Analyze practice "T" joints for incorrect technique and correct any deficiencies.
5. Produce a series of "T" joint welds for evaluation in the flat, horizontal, vertical and overhead positions.
6. Evaluate a sample set of "T" welds. List and explain the defects in each sample.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain purpose and process of welding "T" joints to the whole class. List examples of job applications for "T" joint welding process.
2. Demonstrate "T" joint welding techniques to small groups.
3. Assign advanced level students to prepare and present a small group demonstration of "T" joint welding techniques.
4. Prepare a set of sample standard "T" joints to provide a basis for student comparison and evaluation of their work.
5. Help individual students to develop correct "T" joint welding techniques.
6. Show film/video on oxyacetylene welding techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding sets.

2. Soapstone, welding filler rod, straight edge, tape rule, striker, wire brush, tip cleaner, and pliers.

3. Student sets of personal welding protective equipment.

4. Various thicknesses of mild steel sheet and plate.

5. Set of example plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc., South Holland, IL. pp. 8, 115-145. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 53-140. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Company, Inc., Encino, CA. pp. 234. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc., Encino, CA. pp. 161-175. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co. Novato, CA. pp. 216-219. 1984.

2.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified welds.

2.5 **TASK:** Welds outside corner joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment and various thicknesses of mild steel sheet and plate,

EVALUATION: welds outside corner joints.

STANDARD: The finished beads will include correct angle of joints, travel speed, width and height of the bead, torch distance and angle, gas mixture, and minimum overlap.

STUDENT LEARNING EXPERIENCES:

1. Measure and mark plates to the specified sizes.
2. Run a series of practice outside corner joint welds in the flat, horizontal, vertical and overhead positions.
3. Compare the practice beads to a sample set of standard outside corner joint plates.
4. Analyze practice joints for incorrect technique and correct any deficiencies.
5. Produce a series of outside corner joint welds in the flat, horizontal, vertical and overhead positions for evaluation.
6. Evaluate a set of outside corner joints. List and explain the defects in each sample.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain purpose and process of lap welding to the whole class. List examples of job applications for outside corner joint welding process.
2. Demonstrate outside corner joint welding techniques to small groups.
3. Assign advanced level students to prepare and present a small group demonstration of outside corner joint welding techniques.
4. Prepare a set of sample outside corner joint plates to provide a basis for student comparison and evaluation of their work.

5. Help individual students to develop correct outside corner joint welding techniques.

6. Show film/video on oxyacetylene welding techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding sets.

2. Soapstone, welding filler rod, straight edge, tape rule, striker, wire brush, tip cleaner, and pliers.

3. Student sets of personal welding protective equipment.

4. Various thicknesses of mild steel sheet and plate.

5. Set of example plates.

RESOURCES:

Books;
Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 8, 115-145. 1984.

Jeffus, Larry and Harold V. Johnson, WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 53-140. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Company Inc., Encino, CA. pp. 234. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc., Encino, CA. pp. 161-175. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co., Novato, CA. pp. 216-219. 1984.

2.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified welds.

2.6 **TASK:** Welds pipe in the 2G, 5G and 6G positions.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment, two or more pieces of mild steel pipe two inches or less in diameter,

EVALUATION: weld pipe in the 2G, 5G and 6G positions.

STANDARD: Finished welds will indicate correct fit and alignment; travel speed; width, height, penetration, torch distance, angle and gas mixture. Overlap and undercut will be minimized.

STUDENT LEARNING EXPERIENCES:

1. Research and report on the skill and training requirements for a job in pipe welding.
2. Measure, mark, and cut pipe to specified lengths.
3. Run a series of practice pipe welds in the 2G, 5G and 6G positions.
4. Compare the practice welds to a sample set of standard 2G, 5G and 6G welds.
5. Analyze practice welds for incorrect technique and correct any deficiencies.
6. Produce a series of pipe joint welds in the 2G, 5G and 6G positions for evaluation.
7. Evaluate sample pipe welds. List and explain the defects in each sample.
8. Apply pipe welding skills to the production of an "all position" welding fixture.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate pipe cutting equipment and techniques to the whole class.
2. Describe the use of back-up rings, alignment jigs and pipe holding fixtures to the whole class.

3. Demonstrate pipe weld joint preparation to the whole class.

4. Explain purpose and process of pipe welding to the whole class. List examples of job applications for pipe joint welding process.

5. Demonstrate pipe joint welding techniques to small groups.

6. Assign advanced level students to prepare and present a small group demonstration of pipe joint welding techniques.

7. Prepare a set of sample pipe welds to provide a basis for student comparison and evaluation of their work.

8. Help students develop correct pipe welding techniques on an individual basis.

9. Show film/video on pipe welding welding techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding sets.

2. Soapstone, tape rule, welding filler rod, striker, tip cleaner, wire brush, and pliers.

3. Horizontal bandsaw, cold saw, or friction saw; pedestal grinder and portable electric hand grinder.

4. Pipe clamping or holding fixture(s).

5. Student sets of personal welding protective equipment.

6. Various diameters of steel pipe and tube.

7. Set of example pipe welds.

8. Examples of representative types of back-up rings.

RESOURCES:

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 526-532. 1984.

Jeffus, Larry and Harold V. Johnson, WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 135-136. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Company Inc., Encino, CA. pp. 247-251. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc., Encino, CA. pp. 173-175. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill Book Co. Novato, CA. pp. 233-254. 1984.

Charts;
FILLER METAL COMPARISON CHARTS, American Welding Society, 1986 284 pp.

3.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified brazed joints.

3.1 **TASK:** Cleans joint area.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given wire brushing/grinding tools and equipment, solvents and various thicknesses of mild steel sheet, plate, and cast iron,

EVALUATION: cleans joint area.

STANDARD: Cleaned joints should be free of dirt, grease, oil and oxidation.

STUDENT LEARNING EXPERIENCES:

1. Explain the relationship between correct joint area preparation and braze joint quality.
2. List and describe the steps necessary to prepare mild steel for brazing.
3. List and describe the steps necessary to prepare clean cast iron for brazing.
4. List and describe the steps necessary to prepare dirty or greasy cast iron for brazing.
5. Measure, mark, and cut stock to specified size.
6. Explain the safety considerations for using solvents in the welding lab.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate braze joint preparation techniques to the whole class.
2. Divide class into three small groups, each group working on one joint preparation technique. Rotate groups through each technique.
3. Assign three types of materials to be prepared for brazing. Work with individual students as they prepare stock for brazing.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Various thicknesses of hot and cold rolled mild steel.

2. Cracked or broken iron castings.

3. Portable electric hand grinder, wire brush, tape rule, soapstone, and cleaning solvents.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland IL. pp. 16, 213-21. 1976.

Jeffus, Larry and Harold V. Johnson, WELDING PRINCIPLES AND APPLICATION Delmar Publishers Inc., Albany, NY. pp. 444-445. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 387-594. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 195-198. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 169-174. 1984.

BRAZING MANUAL, American Welding Society, (American National Standard) Miami, FL. 309 pp. 1976.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 370-438. 1978.

3.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified brazed joints.

3.2 **TASK:** Brazes a butt joint.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment, brazing materials, mild steel sheet and plate,

EVALUATION: brazes a butt joint.

STANDARD: Evidence of correct joint area preparation, capillary action, heat, and application of flux will be determined by evaluating the appearance of the finished brazed joint(s).

STUDENT LEARNING EXPERIENCES:

1. Describe the steps necessary to adjust oxyacetylene welding equipment to perform brazing tasks.
2. Describe the function of brazing fluxes.
3. Define brazing.
4. Explain the physical process of brazing.
5. Define the term alloy.
6. List three common metals used in brazing rods.
7. Describe and compare brazing and soldering processes.
8. Describe and compare brazing and fusion welding processes.
9. List industrial applications for brazing processes.
10. Measure, mark, and cut plates to the specified sizes.
11. Run a series of practice brazed butt joints.
12. Test a completed brazed practice plate by bending.
13. Compare the practice beads to a sample set of standard brazed butt-joints.
14. Produce a set of brazed butt joints for final evaluation.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate and explain the proper selection of torch tip size and adjustment of regulator pressures to the whole class.

2. Explain oxyacetylene brazing processes relate learning activities to industrial/job applications.

3. Demonstrate brazing techniques to small groups.

4. Assign advanced level students to prepare and present small group demonstrations of brazing techniques.

5. Prepare a set of sample standard brazed plates to provide a basis for student comparison and evaluation of their work.

6. Assist individual students in developing correct equipment adjustment and brazing technique.

7. Show film/video on oxyacetylene brazing techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding set(s).

2. Shear and mechanical straight line cutting torch.

3. Soapstone, straight edge, tape rule, striker, tip cleaner, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Various thicknesses of mild steel sheet and plate.

6. Brazing flux, flux coated and bare brazing rod.

7. Sets of example brazed plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 194-216. 1984.

Jeffus, Larry and Harold V.Johnson, WELDING PRINCIPLES AND APPLICATION. Delmar Publishers Inc., Albany, NY. p. 130. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 29, 586-594. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe, Publishing Co., Encino, CA. pp. 196-197. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 151-161. 1984.

Charts;

FILLER METAL COMPARISON CHARTS, American Welding Society, Miami, FL. 1986.

3.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified brazed joints.

3.3 **TASK:** Brazes a lap joint.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment, brazing materials, mild steel sheet and plate,

EVALUATION: brazes a lap joint.

STANDARD: The finished joint will show correct joint preparation, bead width and height, capillary action, and flux application.

STUDENT LEARNING EXPERIENCES:

1. Measure, mark, and cut plates to the specified size.
2. Run a series of practice brazed lap joints.
3. Test a completed brazed practice lap joint by bending.
4. Compare the practice lap joints to a sample set of standard brazed plates.
5. Produce a set of brazed lap joints for final evaluation.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate brazing a lap joint to small groups.
2. Assign advanced level students to prepare and present small group demonstrations of lap joint brazing techniques.
3. Prepare a set of sample brazed lap joints to provide a basis for student comparison and evaluation of their work.
4. Assist individual students in developing correct equipment adjustment and brazing technique.
5. Show film/video on oxyacetylene brazing techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding set(s).
2. Shear and mechanical straight line cutting torch.
3. Soapstone, straight edge, tape rule, striker, tip cleaner, wire brush, and pliers.
4. Student sets of personal welding protective equipment.
5. Various thicknesses of mild steel sheet and plate.
6. Brazing flux, flux coated and bare brazing rod.
7. Sets of example brazed plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 194-216. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS, Delmar Publishers Inc., Albany, NY. p. 130. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 29, 586-594. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 219-312. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 151-161. 1984.

3.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified brazed joints.

3.4 **TASK:** Brazes an outside corner joint.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment, brazing materials, mild steel sheet and plate,

EVALUATION: brazes an outside corner joint.

STANDARD: The completed joint will show correct joint area preparation, capillary action, heat input, alignment, and application of flux.

STUDENT LEARNING EXPERIENCES

1. Measure, mark, and cut plates to the specified sizes.
2. Run a series of practice brazed outside corner joints.
3. Test a completed brazed outside corner joint by bending.
4. Compare the practice beads to a sample set of standard brazed outside corner joints.
5. Produce a brazed outside corner joint for final evaluation.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate brazing an outside corner joint to small groups.
2. Prepare a set of sample standard brazed plates to provide a basis for student comparison and evaluation of their work.
3. Assist individual students in developing correct equipment adjustment and brazing technique.
4. Show film/video on oxyacetylene brazing techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding set(s).

2. Shear and mechanical straight line cutting torch.

3. Soapstone, straight edge, tape rule, striker, tip cleaner, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Various thicknesses of mild steel sheet and plate.

6. Brazing flux, flux coated and bare brazing rod.

7. Sets of example brazed plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co. Inc., South Holland, IL. pp. 16, 213-216. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. p. 444-445. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. 587-594. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 195-198. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 169-174. 1984.

3.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified brazed joints.

3.5 **TASK:** Brazes a "T" joint.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment, brazing materials, mild steel sheet and plate,

EVALUATION: brazes a "T" joint.

STANDARD: The completed joint will show correct joint area preparation, capillary action, heat input, alignment, and application of flux.

STUDENT LEARNING EXPERIENCES

1. Measure, mark, and cut plates to the specified sizes.
2. Run a series of practice brazed "T" joints bonding sheet steel to steel plate of heavier gauge.
3. Test a completed practice "T" joint by bending.
4. Compare the practice "T" joint to a sample set of standard brazed "T" joints.
5. Produce a set of brazed "T" joints for final evaluation.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate brazing a "T" joint to small groups.
2. Prepare a set of sample standard "T" joints to provide a basis for student comparison and evaluation of their work.
3. Assist individual students in developing correct equipment adjustment and brazing technique.
4. Show film/video on oxyacetylene brazing techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding set(s).
2. Shear and mechanical straight line cutting torch.
3. Soapstone, straight edge, tape rule, striker, tip cleaner, wire brush, and pliers.
4. Student sets of personal welding protective equipment.
5. Various thicknesses of mild steel sheet and plate.
6. Brazing flux, flux coated and bare brazing rod.
7. Sets of example brazed plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 16, 213-216. 1984.

Jeffus, Larry and Harold V. Johnson, WELDING PRINCIPLES AND APPLICATIONS Delmar Publishers Inc., Albany, NY. p. 444-445. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 587-594. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 195-198. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 169-174. 1984.

3.0 **COMPETENCY/SKILL:** Uses oxyacetylene equipment to produce specified brazed joints.

3.6 **TASK:** Brazes a cast iron butt joint.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxyacetylene welding equipment, brazing materials, mild steel sheet and plate,

EVALUATION: brazes a cast iron butt joint.

STANDARD: The completed joint will show correct joint area cleaning and preparation capillary action, heat, and application of flux.

STUDENT LEARNING EXPERIENCES

1. Explain the effect which joint preparation grinding has on the ultimate strength of a brazed cast iron joint.
2. Explain the effect of excessive or uneven heat on iron castings.
3. Explain the term pre-heat and identify the correct preheating temperature range for cast iron.
4. Explain the effect of rapid cooling on cast iron strength and hardness.
5. List the characteristics of grey cast, malleable cast and white cast iron.
6. List the steps in preparing cast iron for brazing.
7. Practice preparing and brazing a series of cast iron butt joints.
8. Test a completed cast iron butt joint by breaking across the joint line.
9. Compare the practice beads to a sample set of standard brazed plates.
10. Produce a set of brazed cast iron butt joints for final evaluation.
11. Prepare a sample cast iron butt joint for display by sawing and polishing a cross section.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss/demonstrate cast iron brazing preparation techniques to the whole class.

2. Demonstrate and explain the proper selection of torch tip size and adjustment of regulator pressures.

3. Demonstrate cast iron brazing techniques to small groups.

4. Prepare a set of sample brazed cast iron butt joints to provide a basis for student comparison and evaluation of their work.

5. Prepare a set of sample brazed iron castings to indicate the repair possibilities of brazing.

6. Assist individual students in developing correct equipment adjustment and brazing technique.

7. Show film/video on oxyacetylene brazing techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Oxyacetylene welding set(s).

2. Portable band saw, grinders, and stationary band saw.

3. Soapstone, straight edge, tape rule, striker, tip cleaner, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Various thicknesses of iron castings.

6. Brazing flux, flux coated and bare brazing rod.

7. Sets of example brazed iron castings.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 213-214. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS Delmar Publishers Inc., Albany, NY. p. 445. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 197-198. 1984.

4.0 **COMPETENCY/SKILL:** Uses AC or DC shielded metal arc welding (SMAW) equipment to produce specified welds.

4.1 **TASK:** Welds pads, butt, lap, "T" and "V" groove joints in the flat position.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of mild steel electrodes, and various thicknesses of mild steel plate,

EVALUATION: welds pads, butt, lap, "T", and "V" groove joints in the flat position.

STANDARD: Finished joints will show correct bead width, electrode angles, arc length, speed of travel, amperage setting, electrode manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Apply the safety rules and procedures for SMAW equipment.
2. Name the parts of SMAW machines and describe the function and method of adjustment of each component.
3. List and explain the applications for SMAW machines.
4. List six jobs in industry which require SMAW skills.
5. Explain the physical process of SMAW.
6. Measure and mark plates to specified sizes.
7. Set up the SMAW work station.
8. Run a series of flat position plates covering practice in padding, butt joints, lap joints, "T" joints, and "V" groove joints.
9. Compare the practice plates to a sample set of standard flat position plates.
10. Analyze the practice plates for incorrect technique and correct any deficiencies.
11. Produce a set of five specified plates welded in the flat position for final evaluation.
12. Correctly shut down the SMAW station.
13. Evaluate a set of SMAW flat position plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate proper set up and adjustment of SMAW equipment to the whole class.

2. Display a variety of mild steel electrodes and explain their characteristics to the whole class.

3. Demonstrate five specified flat position welds to small groups.

4. Help students weld specified plates on a small group basis.

5. Assist individual students to correctly use SMAW equipment to produce specified flat position plates.

6. Assign advanced level students to prepare and present a small group or individual demonstration on flat position welding on specified plates.

7. Prepare a set of sample flat position plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Various thicknesses of steel plate.

6. Set of flat position sample plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 18, 217-286. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 167-225. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 299-370. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 219-312. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. McGraw-Hill, Inc. Novato, CA. pp. 364-406. 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 1-76. 1978.

NEW LESSONS IN ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 1-1 to 1-60. 1973.

THE PROCEDURE HANDBOOK OF ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 6.2-1 to 6.2-54. 1973.

Booklets;
GAS METAL ARC WELDING, American Welding Society, (American National Standard) Miami, FL. 58 pp. 1979.

COVERED CARBON STEEL ARC WELDING ELECTRODES, SPECIFICATIONS FOR, American Welding Society, (American National Standard) Miami, FL. 35 pp. 1981.

Computer Programs;
WELDING ELECTRODES IDENTIFICATION Career Aids Inc., Chatsworth, CA.

ARC WELDING Career Aids Inc., Chatsworth, CA.

Video;
ARC WELDING SAFETY Abraxas Basic Courseware Eugene, OR.

SHIELDED METAL ARC - PLATE WELDING: Part I, Career Aids Inc., Chatsworth, CA.

ARC WELDING METHODS, VHW, 28 min. Miller Electric Mfg. Co., Appleton, WI. 1985.

SHIELDED METAL ARC PLATE WELDING, Miller Module Method, (Video training system) VHS, Miller Electric Mfg. Co, Appleton, WI. 1985.

4.0 **COMPETENCY/SKILL:** Uses AC or DC shielded metal arc welding (SMAW) equipment to produce specified welds.

4.2 **TASK:** Welds pads, butt, lap, "T" and "V" groove joints in the horizontal position.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of mild steel electrodes, and various thicknesses of mild steel plate,

EVALUATION: welds pads, butt, lap, "T", and "V" groove joints in the horizontal position.

STANDARD: Finished joints will show correct bead width, electrode angles, arc length, speed of travel, amperage setting, electrode manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Apply the safety rules and procedures for SMAW equipment.
2. Measure and mark plates to specified sizes.
3. Properly set up the SMAW work station.
4. Run a series of horizontal position plates covering practice in padding, butt joints, lap joints, "T" joints, and "V" groove joints.
5. Compare the practice plates to a sample set of standard horizontal position plates.
6. Analyze the practice plates for incorrect technique and correct any deficiencies.
7. Produce a set of 5 specified plates welded in the horizontal position for final evaluation.
8. Correctly shut down the SMAW station.
9. Evaluate a set of specified horizontal position SMAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate five specified horizontal position welds to the whole class.

2. Help students weld specified plates on a small group basis.

3. Assist individual students to correctly use SMAW equipment to produce specified horizontal position plates.

4. Assign advanced level students to prepare and present a small group or individual demonstration on horizontal position welding on specified plates.

5. Prepare a set of sample horizontal position plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Various thicknesses of steel plate.

6. Set of example plates

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 18, 217-286. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 167-225. 1984.

Kennedy Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 299-370. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 219-312. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 364-406. 1984.

NEW LESSONS IN ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 1-61 to 1-65. 1973.

Video;
SHIELDED METAL ARC - PLATE WELDING: Part II. Career Aids Inc., Chatsworth, CA.

SHIELDED METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

4.0 **COMPETENCY/SKILL:** Uses AC or DC shielded metal arc welding (SMAW) equipment to produce specified welds.

4.3 **TASK:** Welds pads, butt, lap, "T" and "V" groove joints in the vertical position.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of mild steel electrodes, and various thicknesses of mild steel plate,

EVALUATION: welds pads, butt, lap, "T", and "V" groove joints in the vertical position.

STANDARD: Finished joints will show correct bead width, electrode angles, arc length, speed of travel, amperage setting, electrode manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Apply the safety rules and procedures for SMAW equipment.
2. Measure and mark plates to specified sizes.
3. Properly set up and adjust the SMAW work station.
4. Run a series of vertical position plates covering practice in padding, butt joints, lap joints, "T" joints, and "V" groove joints.
5. Compare the practice plates to a sample set of standard vertical position plates.
6. Analyze the practice plates for incorrect technique and correct any deficiencies.
7. Produce a set of 5 specified plates welded in the vertical position for final evaluation.
8. Correctly shut down the SMAW station.
9. Evaluate a set of specified vertical position SMAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate five specified vertical position welds to the whole class.

2. Help students weld specified plates on a small group basis.

3. Assist individual students to correctly use SMAW equipment to produce specified vertical position plates.

4. Assign advanced level students to prepare and present a small group or individual demonstration on vertical position welding on specified plates.

5. Prepare a set of sample vertical position plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Various thicknesses of steel plate.

6. Set of example vertical position plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 18, 217-280. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 167-225. 1984.

Kennedy Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 299-370. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 219-312. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, Ca. pp. 364-406. 1984.

NEW LESSONS IN ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 1-66 to 1-84. 1973.

Video;
SHIELDED METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

4.0 **COMPETENCY/SKILL:** Uses AC or DC shielded metal arc welding (SMAW) equipment to produce specified welds.

4.4 **TASK:** Welds pads, butt, lap, "T", and "V" joints in the overhead position.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of mild steel electrodes, and various thicknesses of mild steel plate,

EVALUATION: welds pads, butt, lap, "T", and "V" groove joints in the overhead position

STANDARD: Finished joints will show correct bead width, electrode angles, arc length, speed of travel, amperage setting, electrode manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Apply the safety rules and procedures for SMAW equipment.
2. Measure and mark plates to specified sizes.
3. Properly set up and adjust the SMAW work station.
4. Run a series of overhead position plates covering practice in padding, butt joints, lap joints, "T" joints, and "V" groove joints.
5. Compare the practice plates to a sample set of standard overhead position plates.
6. Analyze the practice plates for incorrect technique and correct any deficiencies.
7. Produce a set of 5 specified plates welded in the overhead position for final evaluation.
8. Correctly shut down the SMAW station.
9. Evaluate a set of specified overhead position SMAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate proper set up and adjustment of SMAW equipment to the whole class.

2. Display a variety of mild steel electrodes and explain their characteristics to the whole class.

3. Demonstrate five specified overhead position welds to the whole class.

4. Help students weld specified plates on a small group basis.

5. Assist individual students to correctly use SMAW equipment to produce specified overhead position plates.

6. Assign advanced level students to prepare and present a small group or individual demonstration on overhead position welding on specified plates.

7. Prepare a set of sample overhead position plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Various thicknesses of steel plate.

6. Set of example overhead position plates

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 18, 217-286. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 167-225. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 299-370. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 219-312. 1984.

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Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 364-406. 1984.

NEW LESSONS IN ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 1-85 to 1-90. 1973.

Video;
SHIELDED METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

4.0 **COMPETENCY/SKILL:** uses AC or DC shielded metal arc welding (SMAW) equipment to produce specified welds.

4.5 **TASK:** Welds pipe in the 2G position.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of mild steel electrodes, and two or more pieces of schedule 40 mild steel pipe, 3 inches or larger in diameter,

EVALUATION: welds pipe in the 2G position.

STANDARD: Finished pipe joints will show correct bead width, penetration electrode angles, arc length, speed of travel, amperage setting, electrode manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Apply the safety rules and procedures for SMAW equipment.
2. List a number of jobs in industry which require SMAW pipe welding skills.
3. Measure and mark pipe to specified sizes.
4. Operate various hand and mechanical pipe beveling devices.
5. Properly set up and adjust the SMAW work station.
6. Run a series of practice beads on pipe in the 2G position
7. Compare the practice beads to a sample set of standard 2G position pipe welds.
8. Analyze the practice 2G position pipe welds for incorrect technique and correct any deficiencies.
9. Produce a set of four 2G position pipe welds showing root pass, hot pass, filler pass, and cover passes.
10. Correctly shut down the SMAW station.
11. Evaluate a set of specified 2G position pipe welds and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Display a variety of mild steel electrodes which are commonly used for pipe welding and explain their characteristics to the whole class.

2. Demonstrate root, hot, filler, and cover passes in the 2G position to the whole class.

3. Help students weld pipe in the 2G position on a small group basis.

4. Assist individual students to correctly use SMAW equipment to produce pipe welds in the 2G position.

5. Assign advanced level students to prepare and present a small group or individual demonstration on the 2G pipe welding position.

6. Prepare a set of sample 2G position pipe welds to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Schedule 40 mild steel pipe, 3 inches or larger in diameter.

6. Hand or mechanical pipe beveling equipment.

7. Set of example 2G pipe welds.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 514-525. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 249-26. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 531-548. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., pp. 424-440. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 233-254, 411-414. 1984.

Workbook: SHIELDED METAL-ARC PIPE WELDING (UPHILL) Hobart School of Welding Technology. (Classic) pp. 1-33. 1969.

NEW LESSONS IN ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 1-117 to 1-136. 1973.

Video;
SHIELDED METAL ARC-PIPE WELDING Career Aids Inc., Chatsworth, CA.

SHIELDED METAL ARC PIPE WELDING, Miller Module Method, (Video training system), VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

4.0 **COMPETENCY/SKILL:** Uses AC or DC shielded metal arc welding (SMAW) equipment to produce specified welds.

4.6 **TASK:** Welds pipe in the 5G position.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of mild steel electrodes, and two or more pieces of schedule 40 mild steel pipe, 3 inches or larger in diameter,

EVALUATION: welds pipe in the 5G position.

STANDARD: Finished pipe joints will show correct bead width, penetration electrode angles, arc length, speed of travel, amperage setting, electrode manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Apply the safety rules and procedures for SMAW equipment.
2. Measure and mark pipe to specified sizes.
3. Operate various hand and mechanical pipe beveling devices.
4. Properly set up and adjust the SMAW work station.
5. Run a series of practice beads on pipe in the 5G position.
6. Compare the practice beads to a sample set of standard 5G position pipe welds.
7. Analyze the practice 5G position pipe welds for incorrect technique and correct any deficiencies.
8. Produce a set of four 5G position pipe welds showing root pass, hot pass, filler pass, and cover passes.
9. Correctly shut down the SMAW station.
10. Evaluate a set of specified 5G position pipe welds and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate root, hot, filler, and cover passes in the 5G position to the whole class.

2. Help students weld pipe in the 5G position on a small group basis.

3. Assist individual students to correctly use SMAW equipment to produce pipe welds in the 5G position.

4. Assign advanced level students to prepare and present a small group or individual demonstration on the 5G pipe welding position.

5. Prepare a set of sample 5G position pipe welds to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Schedule 40 mild steel pipe, 3 inches or larger in diameter.

6. Hand or mechanical pipe beveling equipment.

7. Set of example 5G pipe welds.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 514-525. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 249-268. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 531-548. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 424-448. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. pp. 233-254, 411-414. 1984.

Workbook: SHIELDED METAL-ARC PIPE WELDING (UPHILL) Hobart School of Welding Technology. (Classic) pp. 1-33. 1968.

Workbook: SHIELDED METAL-ARC PIPE WELDING (DOWNHILL) Hobart School of Welding Technology. (Classic) pp. 1-29. 1968.

NEW LESSONS IN ARC WELDING The Lincoln Electric Company, Cleveland, OH. pp. 1-117 to 1-136. 1973.

Video;
SHIELDED METAL ARC PIPE WELDING, Miller Module Method (Video training system) VHS, Miller Mfg. Co., Appleton, WI. 1985.

4.0 **COMPETENCY/SKILL:** Uses AC or DC shielded metal arc welding (SMAW) equipment to produce specified welds.

4.7 **TASK:** Welds pipe in the 6G position.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of mild steel electrodes, and two or more pieces of schedule 40 mild steel pipe, 3 inches or larger in diameter,

EVALUATION: welds pipe in the 6G position.

STANDARD: Finished pipe joints will show correct bead width, penetration, electrode angles, arc length, speed of travel, amperage setting, electrode manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Apply the safety rules and procedures for SMAW equipment.
2. Measure and mark pipe to specified sizes.
3. Properly set up and adjust the SMAW work station.
4. Run a series of practice beads on pipe in the 6G position
5. Compare the practice beads to a sample set of standard 6G position pipe welds.
6. Analyze the practice 6G position pipe welds for incorrect technique and correct any deficiencies.
7. Produce a set of four 6G position pipe welds showing root pass, hot pass, filler pass, and cover passes.
8. Correctly shut down the SMAW station.
9. Evaluate a set of specified 6G position pipe welds and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate root, hot, filler, and cover passes in the 6G position to the whole class.

2. Help students weld pipe in the 6G position on a small group basis.

3. Assist individual students to correctly use SMAW equipment to produce pipe welds in the 6G position.

4. Assign advanced level students to prepare and present a small group or individual demonstration on the 6G pipe welding position.

5. Prepare a set of sample 6G position pipe welds to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Schedule 40 mild steel pipe, 3 inches or larger in diameter.

6. Hand or mechanical means of beveling pipe.

7. Set of example 6G pipe welds.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 514-525. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 249-268. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 531-548. 1980.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 424-447. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 233-254, 411-414. 1984.

5.0 **COMPETENCY/SKILL:** Uses AC or DC arc cutting equipment to produce specified cuts.

5.1 **TASK:** Uses Shielded Metal-Arc Cutting (S.M.A.C.) equipment.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a variety of electrodes and various thicknesses of mild steel plate,

EVALUATION: uses shielded metal-arc cutting (S.M.A.C.) equipment.

STANDARD: Observation of proper equipment adjustment, correct electrode selection/manipulation, and smoothness and accuracy of the completed cuts will provide a basis for evaluation.

STUDENT LEARNING EXPERIENCES:

1. Identify and explain the process of cutting steel with deep penetrating mild steel electrodes.
2. Identify and explain the process of cutting steel with special cutting electrodes. Example: Eutectic Cutrode.
3. Explain and apply special safety considerations for cutting steel with electric arc processes.
4. List and explain the industrial applications for electrode arc cutting.
5. Measure and mark plates to specified sizes.
6. Use deep penetrating mild steel electrodes to cut mild steel in the flat, horizontal, vertical and overhead positions.
7. Use special cutting electrodes to cut mild steel in the flat, horizontal, vertical and overhead positions.
8. Use special cutting electrodes to pierce mild steel in the flat, horizontal, vertical and overhead positions.
9. Perform grooving operations in heavy steel plate using solid steel core arc cutting electrodes.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate proper set up and adjustment of SMAW equipment to perform cutting operations to the whole class.

2. Display and explain the characteristics of a variety of deep penetrating mild steel and special cutting electrodes.

3. Demonstrate and explain the correct use of protective clothing for arc cutting to the whole class.

4. Assign students to small groups or teams to rotate through arc cutting processes.

5. Help students perform electrode arc cutting, piercing and grooving jobs on a small group basis.

6. Assist individual students to correctly use electrode arc cutting and grooving processes.

7. Prepare a set of sample cut/grooved/pierced plates to provide a comparison of student work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, chipping hammer, wire brush, and pliers.

4. Student sets of personal welding protective equipment.

5. Number 10 to 14 helmet lenses.

6. Leather capes and sleeves for each station used for vertical and overhead cutting.

7. Various thicknesses of steel plate.

8. Set of sample plates showing examples of S.M.A.C. cutting.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 25, 404-405. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Co., Encino, CA. p. 408. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 318-326. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 305-312. 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 499-516. 1978.

5.0 **COMPETENCY/SKILL:** Uses AC or DC arc cutting equipment to produce specified cuts.

5.2 **TASK:** Uses Carbon-Arc Cutting (C.A.C.) equipment.

ERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, a carbon arc cutting torch, and various thicknesses of mild steel plate,

EVALUATION: uses carbon arc cutting equipment.

STANDARD: Cuts will extend completely through the steel plate and indicate correct machine setting, electrode travel and angle.

STUDENT LEARNING EXPERIENCES:

1. Identify and explain the process of cutting steel with carbon arc cutting equipment (C.A.C.).
2. List two advantages of using carbon arc cutting over oxy-acetylene cutting.
3. Identify and list the characteristics of carbon and graphite electrodes.
4. Explain and apply special safety considerations for cutting steel with carbon arc processes.
5. Explain how carbon arc cutting would be used in industry.
6. Measure, mark, and cut plates to specified sizes.
7. Use carbon arc cutting processes to cut mild steel in the flat position.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate hook up and adjustment of the carbon arc torch to the whole class.
2. Demonstrate and explain the correct use of protective clothing for carbon arc cutting to the whole class.
3. Demonstrate carbon arc cutting techniques using both carbon and graphite electrodes to small groups.
4. Assign students to small groups or teams to rotate through carbon arc cutting processes.

5. Help students perform carbon arc cutting jobs on a small group basis.

6. Assist individual students to correctly use carbon arc cutting processes.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Carbon electrode holder.

3. An assortment of graphite and carbon electrodes.

4. Welding booths equipped with all position clamping devices.

5. Tape rule, soapstone, and pliers.

6. Student sets of personal welding protective equipment.

7. Number 10 to 14 lenses for welding helmets.

8. Various thicknesses of steel plate.

9. Set of plates showing examples of carbon arc cutting.

RESOURCES:

Books;
Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 383-386 and 399-400. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Co., Encino, CA. p. 414. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 318-326. 1984.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. pp. 305-312. 1984.

Booklet;
AIR CARBON-ARC GOUGING AND CUTTING, RECOMMENDED PRACTICES FOR, The American Welding Society, (Classic) (American National Standard) Miami, FL. 29 pp. 1979.

5.0 **COMPETENCY/SKILL:** Uses AC or DC arc cutting equipment to produce specified cuts.

5.3 **TASK:** Uses Air Carbon-Arc Cutting (A.C.A.C.) equipment.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given SMAW welding equipment, an air carbon arc cutting torch, and various thicknesses of mild steel plate,

EVALUATION: uses air carbon-arc cutting (A.C.A.C.) equipment.

STANDARD: Gouge depth and contours will be evaluated for indications of correct current adjustment, electrode angle, and travel speed. Air carbon arc cuts will be no more than 1/8 to 3/16 inch wider than the diameter of the electrode and have a minimum of spatter.

STUDENT LEARNING EXPERIENCES:

1. Identify and explain the process of cutting steel with air carbon-arc cutting equipment (A.C.A.C.).
2. Identify and explain the process of gouging steel with air carbon-arc cutting equipment (A.C.A.C.).
3. List two advantages of using air carbon-arc cutting over oxy-acetylene cutting.
4. List the advantage of using air carbon-arc gouging over grinding.
5. Compare and contrast the characteristics of carbon and graphite electrodes.
6. Explain and apply special safety considerations for cutting steel with air carbon-arc processes.
7. List and explain the industrial applications for air carbon-arc cutting.
8. Measure and mark plates to specified sizes.
9. Use an air carbon-arc cutting torch to cut mild steel in the flat, horizontal, vertical and overhead positions.
10. Use an air carbon-arc torch to gouge mild steel in the flat, horizontal, vertical and overhead positions.
11. Use air carbon-arc equipment to prepare steel plate for S.M.A.W. welding processes.
12. Use air carbon-arc equipment to remove S.M.A.W. fillet welds.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate hook up and adjustment of the air carbon-arc torch to the whole class.

2. Demonstrate and explain the correct use of protective clothing for air carbon-arc cutting.

3. Demonstrate air carbon-arc cutting and gouging techniques using both carbon and graphite electrodes to small groups.

4. Assign students to small groups or teams to rotate through air carbon-arc cutting processes.

5. Help students perform air carbon-arc cutting and gouging jobs on a small group basis.

6. Assist individual students to correctly use air carbon-arc cutting and gouging processes.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories.

2. Air-carbon arc torches.

3. An assortment of graphite and carbon electrodes.

4. Welding booths equipped with all position clamping devices.

5. Tape rule, soapstone, and pliers.

6. Student sets of personal welding protective equipment.

7. Number 10 to 14 lenses for welding helmets.

8. Leather capes and sleeves for each station used for vertical and overhead cutting.

9. Various thicknesses of steel plate.

10. Scrap "T" fillet welds to be used for weld removal processes.

11. Set of plates showing examples of air carbon arc cutting and gouging.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Wilcox Co., Inc. South Holland, IL. pp. 22, 386-387 and 400-402. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Co., Encino, CA. pp. 408-414. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 318-326. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. pp. 305-312. 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 507-515. 1978.

5.0 **COMPETENCY/SKILL:** Uses AC or DC arc cutting equipment to produce specified cuts.

5.4 **TASK:** Uses Plasma-Arc Cutting (P.A.C.) equipment

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a manual plasma-arc cutting torch, power source and various thicknesses of mild steel aluminum, and stainless plate,

EVALUATION: use plasma-arc cutting equipment.

STANDARD: Cuts shall be accurate to within 1/16 of an inch to either side of a line for a hand held torch. Correct torch angle shall be determined by examining the cut. The heat affected zone shall be no wider than 1/16 inch.

STUDENT LEARNING EXPERIENCES:

1. Identify four states of matter.
2. Identify the correct definition of plasma.
3. Identify the process of converting gas to plasma and plasma to gas.
4. Explain the process of gas ionization.
5. Identify and list the characteristics of transferred and non-transferred arc plasma torches.
6. Identify and list the characteristics of five types of gases used in plasma-arc cutting.
7. Identify and explain the major parts and controls of the plasma-arc cutting torch and power supply.
8. Explain the need for, and use of, special hearing protection when cutting with plasma-arc process.
9. List and explain the industrial applications for plasma-arc cutting.
10. Measure and mark plates to specified sizes.
11. Use a hand held plasma-arc torch to make practice cuts in mild steel, and aluminum.
12. Use a hand held plasma-arc torch to make demonstration cuts in aluminum, mild steel and stainless steel plate.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss the operation, set up and adjustment of the plasma-arc torch and power supply to the whole class.

2. Demonstrate and explain the correct use of protective clothing and hearing protection for plasma-arc cutting.

3. Assign advanced level students to prepare and present a small group demonstration of plasma-arc cutting.

4. Assign students to small groups or teams to rotate through arc cutting processes.

5. Assist individual students to correctly use plasma-arc and processes.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Hand held plasma-arc torches and power supplies.

2. Welding booths equipped with all position clamping devices.

3. Tape rule, soapstone, and pliers.

4. Student sets of personal welding protective equipment.

5. Student and instructor hearing protection.

6. Number 10 to 14 lenses for helmets.

7. Leather capes and sleeves for each station.

8. Various thicknesses of aluminum, mild steel and stainless steel plate.

9. Set of plates showing examples of plasma-arc cutting.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 26, 392-396 and 406-407. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. The Glencoe Publishing Co., Encino, CA. pp. 413-414. 1982.

O'Brien, R.L. PLASMA ARC METAL WORKING PROCESSES, American Welding Society, Miami, FL. (Classic) 160 pp. 1967.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 323-326. 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 500-507. 1978.

6.0 **COMPETENCY/SKILL:** Uses gas metal arc welding (GMAW) equipment to produce specified welds.

6.1 **TASK:** Welds flat position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GMAW equipment, a variety of mild steel, stainless steel and aluminum electrode wire, and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds flat position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, gun angles, arc length, speed of travel, penetration, voltage setting, gun manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GMAW equipment.
2. Name the parts of GMAW machines and describe the function and method of adjustment of each component.
3. List and explain the applications for GMAW machines.
4. List six jobs in industry which require GMAW skills.
5. Explain the physical process of GMAW.
6. Measure and mark plates to specified sizes.
7. Properly set up the GMAW work station.
8. Run a series of flat position plates covering practice in welding beads, butt joints, lap joints, "T" joints, and "V" groove joints.
9. Compare the practice GMAW plates to a sample set of standard plates which have been welded in the flat position.
10. Analyze the practice plates for incorrect technique and correct any deficiencies.
11. Produce a set of five specified GMAW plates welded in the flat position for final evaluation.

12. Correctly shut down the GMAW station.

13. Evaluate a set of flat position GMAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate proper set up and adjustment of GMAW equipment to the whole class.

2. Display a variety of mild steel, stainless steel, and aluminum electrode wires and explain their characteristics to the whole class.

3. Demonstrate five specified GMAW flat position welds to the whole class.

4. Help students weld specified GMAW plates on a small group basis.

5. Assist individual students to correctly use GMAW equipment to produce specified flat position plates.

6. Assign advanced level students to prepare and present a small group or individual demonstration on GMAW flat position welding of specified plates.

7. Prepare a set of sample flat position GMAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GMAW machines and accessories.

2. An assortment of electrode wire.

3. Necessary shielding gases.

4. Welding booths equipped with all position clamping devices.

5. Tape rule, soapstone, wire cutting pliers.

6. Student sets of personal welding protective equipment.

7. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

8. Set of example flat position GMAW plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 20, 350-382. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 342-389 (Includes FCAW). 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co. Encino, CA. pp. 505-530, (FCAW) 480-504. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 327-377, (FCAW) 378-388. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. pp. 320-461 (Includes FCAW). 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 113-187 (includes FCAW). 1978.

THE PROCEDURE HANDBOOK OF ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 5.3-1 to 5.4-6 (includes FCAW) 6.4-1 TO 6.5-6 (includes FCAW). 1973.

Booklet;

GAS METAL ARC WELDING, RECOMMENDED PRACTICES FOR, American Welding Society, Miami, FL. (American National Standard) 58 pp. 1979.

Videos:

SHORT CIRCUIT METAL TRANSFER, VHS, 25 min. Miller Electric Mfg. Co., Appleton, WI. 1985.

GAS METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

6.0 **COMPETENCY/SKILL:** Uses gas metal arc welding (GMAW) equipment to produce specified welds.

6.2 **TASK:** Welds horizontal position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GMAW equipment, a variety of mild steel, stainless steel and aluminum electrode wire and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds horizontal position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, gun angles, arc length, speed of travel, penetration, voltage setting, gun manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GMAW equipment.
2. Load a different type of electrode wire on the wire feed mechanism and adjust the machine to feed properly.
3. Measure and mark plates to specified sizes.
4. Run a series of horizontal position GMAW plates covering practice in welding beads, butt joints, lap joints, "T" joints, and "V" groove joints.
5. Compare the practice GMAW plates to a sample set of standard plates which have been welded in the horizontal position.
6. Analyze the practice plates for incorrect technique and correct any deficiencies.
7. Produce a set of five specified GMAW plates welded in the horizontal position for final evaluation.
8. Correctly shut down the GMAW station.
9. Evaluate a set of horizontal position GMAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Display a variety of mild steel, stainless steel, and aluminum electrode wires and explain to small groups how the wires are mounted on the feeder.

2. Discuss and demonstrate the proper sequence for removing and replacing wire electrodes and adjusting the wire feed mechanism.

3. Demonstrate five specified GMAW horizontal position welds to the whole class.

4. Help students weld specified GMAW plates on a small group basis.

5. Assist individual students to correctly use GMAW equipment to produce specified horizontal position plates.

6. Assign advanced level students to prepare and present a small group or individual demonstration on GMAW horizontal position welding of specified plates.

7. Prepare a set of sample horizontal position GMAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GMAW machines and accessories.

2. An assortment of electrode wire.

3. Necessary shielding gases.

4. Welding booths equipped with all position clamping devices.

5. Tape rule, soapstone, wire cutting pliers.

6. Student sets of personal welding protective equipment.

7. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

8. Set of example horizontal position GMAW plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 20, 350-382. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 342-389 (Includes FCAW). 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co. Encino, CA. pp. 505-530, (FCAW) 480-504. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 327-377, (FCAW) 378-388. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., pp. 320-461 (Includes FCAW). 1984.

Videos;

GAS METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

6.0 **COMPETENCY/SKILL:** Uses gas metal arc welding (GMAW) equipment to produce specified welds.

6.3 **TASK:** Welds vertical position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GMAW equipment, a variety of mild steel, stainless steel and aluminum electrode wire and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds vertical position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, gun angles, arc length, speed of travel, penetration, voltage setting, gun manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GMAW equipment.
2. Change to a different type of shielding gas and set the flow meter to the proper value for the welding being done.
3. Measure and mark plates to specified sizes.
4. Run a series of vertical position GMAW plates covering practice in welding beads, butt joints, lap joints, "T" joints, and "V" groove joints.
5. Compare the practice GMAW plates to a sample set of standard plates which have been welded in the vertical position.
6. Analyze the practice plates for incorrect technique and correct any deficiencies.
7. Produce a set of five specified GMAW plates welded in the vertical position for final evaluation.
8. Correctly shut down the GMAW station.
9. Evaluate a set of vertical position GMAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss the various types of shielding gases which can be used in GMAW processes, and explain and demonstrate how to correctly change the cylinders.

2. Describe and demonstrate how GMAW bead shapes and penetration are affected by different shielding gases.

3. Demonstrate five specified GMAW vertical position welds to the whole class.

4. Help students weld specified GMAW plates on a small group basis.

5. Assist individual students to correctly use GMAW equipment to produce specified vertical position plates.

6. Assign advanced level students to prepare and present a small group or individual demonstration on GMAW vertical position welding of specified plates.

7. Prepare a set of sample vertical position GMAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GMAW machines and accessories.

2. An assortment of electrode wire.

3. Necessary shielding gases.

4. Welding booths equipped with all position clamping devices.

5. Tape rule, soapstone, wire cutting pliers.

6. Student sets of personal welding protective equipment.

7. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

8. Set of example vertical position GMAW plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 20, 350-382. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 342-389 (Includes FCAW). 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co. Encino, CA. pp. 505-530, (FCAW) 480-504. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 327-377, (FCAW) 378-388. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. pp. 320-461 (Includes FCAW). 1984.

Video;

GAS METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

6.0 **COMPETENCY/SKILL:** Uses gas metal arc welding (GMAW) equipment to produce specified welds.

6.4 **TASK:** Welds overhead position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GMAW equipment, a variety of mild steel, stainless steel and aluminum electrode wire and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds overhead position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, gun angles, arc length, speed of travel, penetration, voltage setting, gun manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GMAW equipment.
2. Change from a single shielding gas to either two (2) or three (3) shielding gases feeding into and from a double or triple unit gas mixer (proportioner) to the torch.
3. Measure and mark plates to specified sizes.
4. Run a series of overhead position GMAW plates covering practice in welding beads, butt joints, lap joints, "T" joints, and "V" groove joints.
5. Compare the practice GMAW plates to a sample set of standard plates which have been welded in the overhead position.
6. Analyze the practice plates for incorrect technique and correct any deficiencies.
7. Produce a set of five specified GMAW plates welded in the overhead position for final evaluation.
8. Correctly shut down the GMAW station.
9. Evaluate a set of overhead position GMAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and explain why it may or may not be advantageous to mix your own shielding gases.

2. Demonstrate how to properly install and adjust a double or triple unit gas mixer to supply a GMAW station.

3. Examine and discuss local suppliers lists of available mixed shielding gases for GMAW.

4. Demonstrate five specified GMAW overhead position welds to the whole class.

5. Help students weld specified GMAW plates on a small group basis.

6. Assist individual students to correctly use GMAW equipment to produce specified overhead position plates.

7. Assign advanced level students to prepare and present a small group or individual demonstration on GMAW overhead position welding of specified plates.

8. Prepare a set of sample overhead position GMAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GMAW machines and accessories.

2. An assortment of electrode wire.

3. Necessary shielding gases.

4. Double or triple unit gas mixer and accessories.

5. Cylinders of different kinds of GMAW shielding gas.

6. Welding booths equipped with all position clamping devices.

7. Tape rule, soapstone, wire cutting pliers.

8. Student sets of personal welding protective equipment.

9. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

10. Set of example overhead position GMAW plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 20, 350-382. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 342-389 (Includes FCAW). 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co. Encino, CA. pp. 505-530, (FCAW) 480-504. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 327-377, (FCAW) 378-388. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 320-461 (Includes FCAW). 1984.

Video;

GAS METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton, WI. 1985.

7.0 **COMPETENCY/SKILL:** Uses gas tungsten arc welding (GTAW) equipment to produce specified welds.

7.1 **TASK:** Welds flat position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GTAW equipment, a variety of mild steel, stainless steel and aluminum filler metal, and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds flat position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, torch angles, filler metal manipulation, arc length, speed of travel, penetration, amperage setting, torch manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GTAW equipment.
2. Name the parts of GTAW machines and describe the function and method of adjustment of each component.
3. Describe three types of tungsten electrodes and explain how they are prepared for use in the GTAW process.
4. Explain why different GTAW processes employ specific welding current polarities.
5. List and explain the applications for GTAW machines.
6. List a number of jobs in industry which require GTAW skills.
7. Explain the physical process of GTAW.
8. Measure and mark plates to specified sizes.
9. Correctly set up the GTAW work station.
10. Weld a series of flat position practice plates consisting of welding beads, butt joints, lap joints, "T" joints, and "V" groove joints.
11. Compare the practice GTAW plates to a sample set of standard plates which have been welded in the flat position.

12. Analyze the practice plates for incorrect technique and correct any deficiencies.

13. Produce a set of five specified GTAW plates welded in the flat position for final evaluation.

14. Correctly shut down the GTAW station.

15. Evaluate a set of flat position GTAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate proper set up and adjustment of GTAW equipment to the whole class.

2. Display a variety of mild steel, stainless steel, and aluminum filler metals and discuss their characteristics with the whole class.

3. Display and discuss the different types of tungsten electrodes which are used in GTAW processes.

4. Discuss and demonstrate the use of proper welding current polarities when using GTAW on specific materials.

5. Demonstrate the proper preparation of tungsten electrodes for use on different metals.

6. Demonstrate five specified GTAW flat position welds to the whole class.

7. Help students weld specified GTAW plates on a small group basis.

8. Assist individual students to correctly use GTAW equipment to produce specified flat position plates.

9. Assign advanced level students to prepare and present a small group or individual demonstration on GTAW flat position welding of specified plates.

10. Prepare a set of sample flat position GTAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GTAW machines and accessories.

2. Necessary shielding gases.

3. An assortment of GTAW filler metals.

4. Welding booths equipped with all position clamping devices.

5. Dedicated tungsten electrode grinding station.

6. Tape rule, soapstone, pliers, stainless steel brush.

7. Student sets of personal welding protective equipment.

8. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

9. Set of example flat position GTAW plates.

RESOURCES:

Books;
Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 19, 287-301, 321-349. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 271-320. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 282-329. 1982.

Minnick, William H. GTAW HANDBOOK. Goodheart-Willcox Co. Inc. South Holland, IL. pp. 5-176. 1985.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 389-423. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. pp. 311-346. 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 77-112. 1978.

THE PROCEDURE HANDBOOK OF ARC WELDING, The Lincoln Electric Company, Cleveland, OH. pp. 9.4-1 to 9.4-12. 1973.

Booklet;
RECOMMENDED PRACTICES FOR GAS TUNGSTEN ARC WELDING, American Welding Society, (American National Standard) Miami, FL. 46 pp. 1980.

Video;
THE GAS TUNGSTEN-ARC WELDING PROCESS, VHS, 25 min. Miller Electric Mfg. Co., Appleton, WI. 1985.

7.0 **COMPETENCY/SKILL:** Uses gas tungsten arc welding (GTAW) equipment to produce specified welds.

7.2 **TASK:** Welds horizontal position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GTAW equipment, a variety of mild steel, stainless steel and aluminum filler metal, and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds horizontal position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, torch angles, filler metal manipulation, arc length, speed of travel, penetration, amperage setting, torch manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GTAW equipment.
2. List two shielding gases which are commonly used with the GTAW process.
3. Explain why different GTAW processes employ specific shielding gas.
4. Measure and mark plates to specified sizes.
5. Correctly set up the GTAW work station.
6. Weld a series of horizontal position practice plates consisting of beads, butt joints, lap joints, "T" joints, and "V" groove joints.
7. Compare the practice GTAW plates to a sample set of standard plates which have been welded in the horizontal position.
8. Analyze the practice plates for incorrect technique and correct any deficiencies.
9. Produce a set of five specified GTAW plates welded in the horizontal position for final evaluation.
10. Correctly shut down the GTAW station.
11. Evaluate a set of horizontal position GTAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Discuss and demonstrate the use of GTAW shielding gases which will be used in the shop.

2. Demonstrate five specified GTAW horizontal position welds to the whole class.

3. Help students weld specified GTAW plates on a small group basis.

4. Assist individual students to correctly use GTAW equipment to produce specified horizontal position plates.

5. Assign advanced level students to prepare and present a small group or individual demonstration on GTAW horizontal position welding of specified plates.

6. Prepare a set of sample horizontal position GTAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GTAW machines and accessories.

2. Necessary shielding gases.

3. An assortment of GTAW filler metals.

4. Welding booths equipped with all position clamping devices.

5. Dedicated tungsten electrode grinding station.

6. Tape rule, soapstone, pliers, stainless steel brush.

7. Student sets of personal welding protective equipment.

8. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

9. Set of example horizontal position GTAW plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 19, 287-301, 321-349. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 271-320. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 282-329. 1982.

Minnick, William H. GTAW HANDBOOK. Goodheart-Wilcox Co. Inc., South Holland, IL. pp. 5-176. 1985.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc., Encino, CA. pp. 389-423. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. pp. 311-346. 1984.

7.0 **COMPETENCY/SKILL:** Uses gas tungsten arc welding (GTAW) equipment to produce specified welds.

7.3 **TASK:** Welds vertical position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GTAW equipment, a variety of mild steel, stainless steel and aluminum filler metal, and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds vertical position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, torch angles, filler metal manipulation, arc length, speed of travel, penetration, amperage setting, torch manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GTAW equipment.
2. Explain the process for selecting the correct shielding gas nozzle size and shape for specific operations.
3. Measure and mark plates to specified sizes.
4. Correctly set up the GTAW work station.
5. Weld a series of vertical position practice plates consisting of beads, butt joints, lap joints, "T" joints, and "V" groove joints.
6. Compare the practice GTAW plates to a sample set of standard plates which have been welded in the vertical position.
7. Analyze the practice plates for incorrect technique and correct any deficiencies.
8. Produce a set of five specified GTAW plates welded in the vertical position for final evaluation.
9. Correctly shut down the GTAW station.
10. Evaluate a set of vertical position GTAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Display a large assortment of GTAW shielding gas nozzles and point out various factors which should be considered in the selection of a particular nozzle.

2. Demonstrate five specified GTAW vertical position welds to the whole class.

3. Help students weld specified GTAW plates on a small group basis.

4. Assist individual students to correctly use GTAW equipment to produce specified vertical position plates.

5. Assign advanced level students to prepare and present a small group or individual demonstration on GTAW vertical position welding of specified plates.

6. Prepare a set of sample vertical position GTAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GTAW machines and accessories.

2. Large assortment of shielding gas nozzles.

3. Necessary shielding gases.

4. An assortment of GTAW filler metals.

5. Welding booths equipped with all position clamping devices.

6. Dedicated tungsten electrode grinding station.

7. Tape rule, soapstone, pliers, stainless steel brush.

8. Student sets of personal welding protective equipment.

9. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

10. Set of example vertical position GTAW plates.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 19, 287-301, 321-349. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 271-320. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 282-329. 1982.

Minnick, William H. GTAW HANDBOOK. Goodheart-Willcox Co. Inc., South Holland, IL. pp. 5-176. 1985.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 389-423. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 311-346. 1984.

7.0 **COMPETENCY/SKILL:** Uses gas tungsten arc welding (GTAW) equipment to produce specified welds.

7.4 **TASK:** Welds overhead position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given GTAW equipment, a variety of mild steel, stainless steel and aluminum filler metal, and various thicknesses of mild steel, stainless steel and aluminum sheet and plate,

EVALUATION: welds overhead position beads, butt joints, lap joints, "T" joints, and "V" groove joints.

STANDARD: Evaluation will be based on an examination of the finished welds and will include: correct bead width, torch angles, filler metal manipulation, arc length, speed of travel, penetration, amperage setting, torch manipulation, and minimum overlap and undercut.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for GTAW equipment.
2. Compare a water cooled GMAW torch to an air-cooled GMAW torch and list advantages and disadvantages of each.
3. List three methods which can be used to maintain the arc when welding with an AC GTAW power source.
4. Measure and mark plates to specified sizes.
5. Correctly set up the GTAW work station.
6. Weld a series of overhead position practice plates consisting of welding beads, butt joints, lap joints, "T" joints, and "V" groove joints.
7. Compare the practice GTAW plates to a sample set of standard plates which have been welded in the overhead position.
8. Analyze the practice plates for incorrect technique and correct any deficiencies.
9. Produce a set of five specified GTAW plates welded in the overhead position for final evaluation.

10. Correctly shut down the GTAW station.

11. Evaluate a set of overhead position GTAW plates and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Compare stripped-down examples of water-cooled and air-cooled GMAW torches and point out advantages and disadvantages of each type.

2. Use drawings, diagrams, or the actual units to explain the methods which are used to propagate the arc in AC GTAW power sources.

3. Demonstrate five specified GTAW overhead position welds to the whole class.

4. Help students weld specified GTAW plates on a small group basis.

5. Assist individual students to correctly use GTAW equipment to produce specified overhead position plates.

6. Assign advanced level students to prepare and present a small group or individual demonstration on GTAW overhead position welding of specified plates.

7. Prepare a set of sample overhead position GTAW plates to provide a basis for student comparison and evaluation of their work.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. GTAW machines and accessories.

2. Stripped-down GTAW torches.

3. Drawings of, diagrams of, or the actual arc propagation devices used on AC GTAW power sources.

4. An assortment of GTAW filler metals.

5. Welding booths equipped with all position clamping devices.

6. Dedicated tungsten electrode grinding station.

7. Tape rule, soapstone, pliers, stainless steel brush.

8. Student sets of personal welding protective equipment.

9. Various thicknesses of mild steel, stainless steel, and aluminum sheet and plate.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 19, 287-301, 321-349. 1984.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 271-320. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 282-329. 1982.

Minnick, William H. GTAW HANDBOOK. Goodheart-Willcox Co. Inc., South Holland, IL. pp. 5-176. 1985.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. pp. 389-423. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 311-346. 1984.

8.0 **COMPETENCY/SKILL:** Performs hardfacing and buildup procedures.

8.1 **TASK:** Builds up worn or damaged base metal to original specifications.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxy-fuel, arc, and thermal spraying equipment, appropriate rods, SMAW electrodes, and electrode wire,

EVALUATION: builds up worn or damaged base metal to original specifications.

STANDARD: Evaluation will be based on an examination of the finished built up items and will include: correct process selection, buildup material selection, performance of process, and serviceability of the finished items.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for oxy-fuel, arc, and thermal spray equipment used for buildup procedures.
2. Describe the difference between buildup and hardfacing operations.
3. Explain why cladding does not serve the same purpose as buildup.
4. Compare the cost of buying a new part with the cost of repairing a damaged or worn part by buildup.
5. List five applications where buildup processes might save you money.
6. Discuss one of the buildup processes and give two examples of its use.
7. Explain the physical process of two buildup operations.
8. Obtain a worn or broken item and restore it to be as close to its new condition as possible by employing buildup processes. (Practice).
9. Correctly set up the selected buildup work station.
10. Perform the required procedures to buildup the worn or damaged item.
11. Finish the item as well as possible with the facilities in the welding lab.

12. Compare the built up item with a sample set of standard repaired examples.

13. Analyze the practice built up item for incorrect technique and correct any deficiencies.

14. Produce a built up sample for evaluation.

15. Correctly shut down the buildup work station.

16. Evaluate a set of buildup repairs and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. List and explain buildup procedures which are routinely used in restoring worn or damaged items to their original specifications.

2. Discuss and demonstrate proper set up and adjustment of buildup equipment which is common to your lab to the whole class.

3. Display three types of buildup filler metal (oxyacetylene and arc), and discuss their applications with the whole class.

4. Demonstrate the buildup of a worn shaft (radially grooved) by the oxyacetylene brazing process.

5. Demonstrate the use of the SMAW process to restore a cutting edge on a cultivator sweep. (Will be hardfaced later).

6. Demonstrate the correct method of oxyacetylene fusion welding buildup to use in restoring a chain sprocket which has damaged AND broken teeth.

7. Discuss metallurgical properties such as toughness, hardness, annealling, effects of quench rate, and machineability which are influenced by the heat of the buildup process.

8. Help students perform specified buildup procedures. (Practice)

9. Assist individual students to correctly use SMAW and oxyacetylene equipment to perform the required buildup jobs.

10. Assign advanced level students to prepare and present a small group or individual demonstration on GTAW and GMAW buildup of worn or broken items.

11. Present a lecture and demonstration of thermal spraying to the whole class.

12. Use thermal spraying to buildup a mild steel plate with a cladding of stainless steel in order to increase the plates resistance to corrosion.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories, oxyfuel equipment and accessories GMAW machines and accessories, GTAW machines and accessories, thermal spraying equipment and accessories.

2. An assortment of filler metals, electrodes, and wires for the above processes.

3. Necessary shielding gases and fluxes.

4. Welding booths equipped with all position clamping devices, positioners, and rotators.

5. Heat treating station(s).

6. Tape rule, soapstone, pliers, chipping hammer.

7. Student sets of personal welding protective equipment.

8. Various worn and broken items to be repaired by buildup procedures.

9. Set of example built up items.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 563-581. 1984.

Giachino, Weeks. WELDING SKILLS. American Technical Publishers, Inc., Alsip, IL. pp. 290-299. 1985.

Jeffus, Larry and Harold V. Johnson WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 135-136, 430-438. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 472-501. 1982.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 494-524. 1984.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 516-523. 1978.

8.0 **COMPETENCY/SKILL:** Performs hardfacing and buildup procedures.

8.2 **TASK:** Applies hardfacing materials to metal surfaces.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given oxy-fuel, arc, and thermal spraying equipment, appropriate rods, SMAW electrodes, and electrode wire,

EVALUATION: applies hardfacing materials to metal surfaces.

STANDARD: Evaluation will be based on an examination of the finished hardfaced items and will include: correct process selection, hardfacing material selection, performance of process, and serviceability of the finished items.

STUDENT LEARNING EXPERIENCES:

1. Learn and apply the safety rules and procedures for oxy-fuel, arc, and thermal spray equipment used for buildup procedures.
2. Define hardfacing.
3. List five alloying elements which are used in iron based rods and electrodes to produce hard facing materials.
4. List two alloying elements which are used in non ferrous rods and electrodes to produce hardfacing materials.
5. List six carbides which can be used as diamond substitutes for hardfacing rods and powders
6. List and define three types of wear which hardfacing can deter.
7. Explain the electric arc spray surfacing pocesses and give two examples of its use.
8. Explain the physical process of metallizing and compare and contrast it to SMAW and carbon arc hardfacing.
9. Using an item which you built up in the preceding unit, (8.1) apply hard facing materials employing a process of your choice.
10. Using an item which you built up in the preceding unit, (8.1) apply hard facing materials employing a process of your instructors choice.
11. Correctly set up the selected hardfacing work station.

12. Perform the required procedures to hardface the selected item. (Practice)

13. Using the item which was hardfaced by the instuctors choice of process, test the hardfacing results and compare them to a specified set of standards. (Practice)

14. Analyze the practice hardfaced items for incorrect technique and correct any deficiencies.

15. Produce a hardfaced sample for evaluation.

16. Correctly shut down the hardfacing work station.

17. Evaluate a set of hardfaced items and list and explain the defects in each.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. List and explain hardfacing procedures which are routinely used in restoring worn or damaged items to their original specifications.

2. Discuss and demonstrate proper set up and adjustment of hardfacing equipment which is common to your lab to the whole class.

3. Display and discuss tubular and wire hardfacing SMAW electrodes with the whole class.

4. Demonstrate the hardfacing of a worn bucket tooth (or equivalent) using the oxyacetlene hardfacing process.

5. Demonstrate the use of the SMAW hardfacing process on the cultivator sweeps which were built up in unit 8.1. (Small group)

6. Show a film/video on hardfacing materials and processes.

7. Help students perform specified hardfacing procedures. (Practice)

8. Assist individual students to correctly use SMAW and oxyacetylene equipment to perform the required hardfacing jobs.

9. Present a lecture and demonstration of hardfacing utilizing the carbon arc in conjunction with hardfacing paste.

10. Use the GTAW process to hardface a small item in small group demonstrations.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. SMAW machines and accessories, oxyfuel equipment and accessories, GTAW machines and accessories.

2. An assortment of hardfacing pastes, filler metals, electrodes, and wires for the above processes.

3. Necessary shielding gases.

4. Welding booths and tables.

5. Hardness testing station(s).

6. Tape rule, soapstone, pliers, chipping hammer.

7. Student sets of personal welding protective equipment.

8. Various worn items to be resurfaced by hardfacing procedures.

9. Set of example hardfaced items.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. pp. 563-581. 1984.

Giachino, Weeks, WELDING SKILLS. American Technical Publishers, Inc., Alsip, IL. pp. 290-299. 1985.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 135-136, 430-438. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. pp. 472-501. 1982.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. pp. 494-524. 1984.

FUNDAMENTALS OF SERVICE. Deere and Company, pp. 61-69. 1979.

THE PROCEDURE HANDBOOK OF ARC WELDING. The Lincoln Electric Company, Cleveland, OH. pp. 13.7-1 to 13.7-20. 1973.

WELDING HANDBOOK, Volume Two, Seventh Edition, American Welding Society, Miami, FL. pp. 517-562. 1978.

9.0 **COMPETENCY/SKILL:** Reads, interprets and draws shop prints.

9.1 **TASK:** Identifies and interprets welding symbols and standard notes from drawings and sketches.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blueprints for a part or assembly to be fabricated,

EVALUATION: identifies and interprets welding symbols and standard notes from drawings and sketches.

STANDARD: Read AWS standard welding schematic symbols to identify fifteen standard weld types and configurations.

STUDENT LEARNING EXPERIENCES:

1. Read and interpret whole and fractional numbers and symbols on drawings and sketches.
2. Convert English standard measurements to metric.
3. Identify the three basic parts of the welding symbol reference line.
4. Explain the location of the meaning of the "arrow side" and the "other side" of the reference line.
5. Correctly name fifteen standard weld symbols.
6. Write the meaning of the weld information specified in the AWS standard symbol.
7. Draw pictorial representations of the welds indicated by AWS weld symbols.
8. Draw AWS weld symbols for pictorial representations of welds.
9. Draw a series of AWS weld symbols on "flash cards", review the cards to associate symbols and meaning.
10. Produce a series of welds based on directions supplied by AWS weld symbols.
11. Draw AWS symbols for sample welds provided.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Use wall charts to explain the system of AWS schematic weld symbol notation to the whole class.

2. Assign students to small groups to practice using weld symbol "flash cards".

3. Assign advanced student(s) the task of developing an AWS weld symbol chart.

4. Assign advanced students the job of preparing a display of weld symbols and samples of the welds they represent.

5. Work with individual students to help them relate welding symbols to welds being performed during skill development assignments.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Commercial or instructor/student prepared wall charts of weld symbols.

2. Examples of welding fabrication blueprints complete with welding symbols.

3. Displays of welds and weld symbols.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL., pp. 63-79. 1984.

Bennet, A. E. and Siy, Louis J. BLUE PRINT READING FOR WELDERS Delmar Publishers, Albany, NY pp. 99-125, example drawings. 1983.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. pp. 487-502. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Second Edition. Glencoe Publishing Co., Encino, CA. pp. 548-576. 1984.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Inc. Encino, CA. pp. 119-134. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. pp. 548-576. 1984.

SYMBOLS FOR WELDING, BRAZING AND NON DESTRUCTIVE EXAMINATION, 1983., Miami, FL.

9.0 **COMPETENCY/SKILL:** Reads, interprets and draws shop prints.

9.2 **TASK:** Reads and interprets shop prints and sketches.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a sketch or set of working drawings or blue prints for a part or assembly to be fabricated,

EVALUATION: reads and interprets shop prints and sketches.

STANDARD: Determine and list part names, numbers of pieces required, order numbers, materials specified, overall size, and types of welds and finish for objects shown in a sketch or shop print.

STUDENT LEARNING EXPERIENCES:

1. Identify and define eight types of lines.
2. Identify and define two different types of dimensioning.
3. Identify and define materials symbols.
4. Identify and select types of welded joints and their symbols.
5. Read and interpret information in notes and specification block.
6. Determine the correct welding and assembly sequence.
7. Calculate the surface area and volume of proposed assemblies.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain types of lines, dimensioning, and material specifications to the whole class.
2. Have students work in small groups to practice reading drawings and sketches.
3. Work with individual students to help them interpret drawings and sketches.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Commercial or instructor prepared shop drawings with the types of lines, dimensioning, and materials symbols indicated.

2. Commercial or instructor/student prepared wall charts of weld symbols.

3. Examples of welding fabrication blueprints complete with welding symbols.

4. Displays of welds and weld symbols.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL. 1984.

Bennet, A. E. and Siy, Louis J. BLUE PRINT READING FOR WELDERS Delmar Publishers, Albany, NY pp. 2-8. 30-42, example drawings. 1983.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Second Edition. Glencoe Publishing Co., Encino, CA. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. 1984.

9.0 **COMPETENCY/SKILL:** Reads, interprets and draws shop prints.

9.3 **TASK:** Sketches pictorial views from orthographic views.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blue prints for a part or assembly consisting of orthographic projections,

EVALUATION: sketches pictorial views from orthographic views.

STANDARD: The pictorial views will indicate the correct relative size and shape of the object shown in the orthographic projection.

STUDENT LEARNING EXPERIENCES:

1. Study simple orthographic projection drawings and sketch pictorial views.
2. Cut orthographic projection shapes from a drawing and assemble as a geometric solid.
3. Sketch a completed geometric solid as a pictorial.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain types of lines, dimensioning, materials to the whole class.
2. Have students work in small groups to practice reading drawings and sketches.
3. Work with individual students to help them interpret drawings and sketches.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Commercial or instructor prepared shop drawings with the types of lines, dimensioning, and materials symbols indicated.

2. Commercial or instructor/student prepared wall charts of weld symbols.

3. Examples of welding fabrication blueprints complete with welding symbols.

4. Displays of welds and weld symbols.

RESOURCES:

Books;

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc., South Holland, IL. 1984.

Bennet, A. E. and Siy, Louis J. BLUE PRINT READING FOR WELDERS Delmar Publishers, Albany, NY pp. 99-20, example drawings. 1983.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY. 1984.

Kennedy, Gower A. WELDING TECHNOLOGY. Second Edition. Glencoe Publishing Co., Encino, CA. 1982.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA. 1984.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc., Novato, CA. 1984.

9.0 **COMPETENCY/SKILL:** Reads, interprets and draws shop prints.

9.4 **TASK:** Constructs solid geometric shapes.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a drawing consisting of a set of orthographic projections,

EVALUATION: constructs solid geometric shapes.

STANDARD: The geometric shapes produced must be accurate three-dimensional representations of the objects described in the orthographic projections.

STUDENT LEARNING EXPERIENCES:

1. Read an English standard rule to a tolerance of + or - 1/16".
2. Transfer orthographic projection from prints to cardboard.
3. Cut cardboard orthographic shapes and assemble them into three dimensional (geometric) solids.
4. Transfer orthographic shapes to steel sheet, cut, assemble and weld into three dimensional solids.
5. Determine the volume of simple three dimensional solids by applying common formulas.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Demonstrate techniques of transferring orthographic projections onto cardboard to the whole class.
2. Demonstrate techniques of cutting and assembling three dimensional shapes to the whole class.
3. Help individual students develop three dimensional shapes from projections.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Large drawings or blue prints of a range of orthographic projections from simple to complex for class demonstrations.

2. Drawings or blue prints of simple orthographic projections.

3. Card board, tag board, matt board or foamcore board.

4. Utility or Exacto knives, cutting boards and masking tape.

5. Light gauge cold rolled mild steel plate.

6. Sheet metal cutting tools and equipment.

7. Oxyfuel or GTAW equipment.

RESOURCES:

Books;
Schell Frank R., and Bill J. Matlock. PRACTICAL PROBLEMS IN MATHEMATICS FOR WELDERS. Delmar Publishers Inc., Albany, NY. pp. 104-138. 1982.

9.0 **COMPETENCY/SKILL:** Reads, interprets and draws shop prints.

9.5 **TASK:** Draws sketches of existing objects.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given drawing materials, and simple welded objects and geometric shapes,

EVALUATION: draws sketches of existing objects.

STANDARD: The drawings should represent the objects to the extent that the objects are recognizable, drawn in perspective and are proportional.

STUDENT LEARNING EXPERIENCES:

1. Draw a series of small or thumbnail sketches of simple geometric shapes.
2. Draw a series of thumbnail sketches of small welded fabrications.
3. Sketch a welded assembly from two different positions.
4. Produce a set of shop sketches or a project to be welded.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain and demonstrate the principles of perspective sketching to the whole class.
2. Arrange to exchange classes for a short period of time with an art or drafting instructor.
3. Have students work in small groups to sketch small objects, rotate groups or objects.
4. Help individual students to develop sketching techniques.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Teacher prepared examples of simple geometric solids. Examples: simple everyday objects painted white, or simple wood shapes.

2. Drawings or newsprint paper, drawing boards, masking tape and pencils.

3. Examples of sketches or drawings.

RESOURCES:

Books;
Goetch, David L., STRUCTURAL DRAFTING Delmar Publishers, Albany, NY. 1982.

9.0 **COMPETENCY/SKILL:** Reads, interprets and draws shop prints.

9.6 **TASK:** Produces a set of working drawings.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given drawing materials, sketches and a project to be fabricated,

EVALUATION: produces a set of working drawings.

STANDARD: The working drawings should contain a minimum of three views in orthographic projection, make use of details, notes and welding symbols.

STUDENT LEARNING EXPERIENCES:

1. Use basic fractional math to produce correct sizes, shapes and dimensions on the working drawing.
2. Read the English rule and engineer's scale to produce correct sizes, shapes scale and dimensions on the working drawing.
3. Draw using the three common views in orthographic projection.
4. Use standard welding symbols to indicate types of welds.
5. Use standard notation to indicate tolerances and sizes.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain and demonstrate producing working drawings using orthographic projection to the whole class.
2. Arrange to exchange classes for a short period of time with a drafting instructor.
3. Work with individual students to help them to develop drafting skills.
4. Work with individual students to help them to develop sketching skills.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sets of drafting instruments, scales and rules.

2. Drawing paper, drawing boards, masking tape and pencils.

RESOURCES:

Books;
Goetch, David L., STRUCTURAL DRAFTING Delmar Publishers, Albany, NY. pp. 73-91. 1982.

10.0 **COMPETENCY/SKILL:** Estimates project costs and time requirements.

10.1 **TASK:** Analyzes drawings to determine scope of work.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blue prints for a part or assembly to be fabricated,

EVALUATION: analyzes drawings to determine scope of work.

STANDARD: Write an evaluation of the complexity and relative size of the proposed job; list the series of steps necessary for completion, determine the approximate time for completion of the job.

STUDENT LEARNING EXPERIENCES:

1. List examples of large and small welding fabrications or assemblies in the area of the welding lab.
2. Study and compare sample sets of working drawings and small finished fabrications.
3. List the steps necessary for the completion of a fabrications shown on a set of prints.
4. Estimate, from drawings, the approximate completion time for a sample fabrication.
5. Determine and list the processes and order of completion for a sample fabrication.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Show slides of large fabrications and matching sets of prints to the whole class.
2. Locate/produce sets of welded assemblies or fabrications and matching drawings or prints for student comparison.
3. Provide small groups of students with sets of prints to discuss and determine scope and sequence.
4. Prepare a set of sample prints to provide student practice in evaluation.
5. Assign individual students to interview a welder to determine how planning is done in the field.
6. Help individual students determine the scope of work for a welded fabrication.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Instructor prepared sets of slides of major welded or fabricated structures in the area. Examples are tanks, materials handling equipment, bridge structures or building structural systems.

2. Sets of plans or prints matching structures shown in the slides in #1 above.

3. Examples of small welded or fabricated projects and working drawings.

4. Sets of sample prints to provide for student evaluation and testing.

RESOURCES:

Books;

Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS Delmar Publishers, Albany, NY. 1983.

Blodget, Omer W. DESIGN OF WELDMENTS, The James F. Lincoln Arc Welding Foundation Cleveland, OH. (general reference) (Classic). 1976.

Smith, Dave WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw-Hill, Inc. Novato, CA. p. 549. 1984.

10.0 **COMPETENCY/SKILL:** Estimates project cost and time requirements.

10.2 **TASK:** Produces a complete list of materials.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blue prints for a part or assembly to be fabricated,

EVALUATION: produces a complete list of materials (bill of materials).

STANDARD: The list of materials should be accurate to within 10% of the actual materials used to produce a specified fabrication.

STUDENT LEARNING EXPERIENCES:

1. Write whole numbers and fractions as required to make lists of materials.
2. Read and interpret sample sets of blueprints and lists of materials.
3. Read and interpret blueprints to determine numbers of pieces and dimensions.
4. Practice developing lists of materials from simple blueprints.
5. Design and produce a "List of Materials Form" including spaces to indicate: 1) number of pieces required, 2) thickness, 3) width, 4) length, and 5) type of material.
6. Design a "List of Materials Format" for use with a micro-computer data base.
7. Produce a complete list of materials for a welded fabrication.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain the correct order for writing materials lists including numbers of pieces required and dimensions to the whole class.
2. Develop sample material lists from blueprint slides with the whole class.

3. Break the class into teams of students, each team with a different blueprint. Have each team interpret the blueprint and develop a list of materials. Rotate each team through the complete set of prints. Post the results for comparison.

4. Work with individual students to help them develop lists of materials.

5. Work with students in the computer lab to develop lists of materials on a data base.

6. Help individual students produce a complete list of materials for a welded fabrication.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sample sets of simple welding fabrication blueprints and cutting lists.

2. Transparencies (35 mm slides) of sample blueprints.

3. Micro-computer lab access.

RESOURCES:

Books;
Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS. Delmar Publishers, Albany, NY. pp. 35-39. 1983.

10.0 **COMPETENCY/SKILL:** Estimates project cost and time requirements.

10.3 **TASK:** Prepares a cutting list.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blue prints for a part or assembly to be fabricated,

EVALUATION: prepares a cutting list.

STANDARD: The list of materials should be accurate to within 10% of the actual materials used to produce a small fabrication.

STUDENT LEARNING EXPERIENCES:

1. Write whole numbers and fractions as required to make cutting lists.
2. Add, subtract, multiply and divide whole numbers and fractions as required to prepare cutting lists.
3. Read and interpret blueprints and lists of materials to determine numbers of pieces and dimensions.
4. Prepare a cutting list for a welded fabrication.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain the procedure for developing a cutting list from a list of materials to the whole class.
2. Develop sample cutting lists from blueprint slides with the whole class.
3. Break the class into teams of students, each team with a different blueprint. Have each team interpret the blueprint and develop a cutting list. Rotate each team through the complete set of prints. Post the results for comparison.
4. Work with students in the computer lab to develop cutting lists on a data base.
5. Work with individual students to help them develop cutting lists for a welded fabrication.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sample sets of simple welding fabrication blueprints and cutting lists.

2. Transparencies (35 mm slides) of sample blueprints.

3. Micro-computer lab access.

RESOURCES:

Books;
Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS Delmar Publishers, Albany, NY. pp. 35-39. 1983.

10.0 **COMPETENCY/SKILL:** Estimate project cost and time requirements.

10.4 **TASK:** Determines fabrication time requirements.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blue prints for a part or assembly to be fabricated,

EVALUATION: determines fabrication time requirements.

STANDARD: The estimation of fabrication time must be within 10% of the actual time required to produce a sample fabrication.

STUDENT LEARNING EXPERIENCES:

1. Write whole numbers and fractions as required to determine fabrication time.
2. Add, subtract, multiply and divide whole numbers and fractions as required to determine fabrication time.
3. Read and interpret blueprints, lists of materials and cutting lists to determine fabrication time requirements.
4. Estimate fabrication time from simple blueprints.
5. Write a computer program to estimate fabrication times.
6. Determine the fabrication time requirements for a welded project.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain the procedure for determining fabrication time from prints, lists of materials and cutting lists to the whole class.
2. Determine fabrication time requirements from blueprint slides with the whole class.
3. Break the class into teams of students, each team with a different blueprint. Have each team interpret the blueprint and estimate fabrication time requirements. Rotate each team through the complete set of prints. Post the results for comparison.
4. Work with students in the computer lab to develop programs for determining fabrication time requirements.
5. Work with individual students to help them estimate fabrication time for a welded fabrication.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sample sets of simple welding fabrication blueprints and cutting lists.

2. Transparencies (35 mm slides) of sample blueprints.

3. Micro-computer lab access.

RESOURCES:

Books;
Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS. Delmar Publishers, Albany, NY. pp. 35-39. 1983.

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10.0 **COMPETENCY/SKILL:** Estimates project cost and time requirements.

10.5 **TASK:** Determines labor cost.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blue prints for a part or assembly to be fabricated,

EVALUATION: determines labor costs.

STANDARD: The estimation of labor cost must be within 10% of the actual cost of production on a sample fabrication.

STUDENT LEARNING EXPERIENCES:

1. Write whole numbers and fractions as required to determine labor costs.
2. Add, subtract, multiply and divide whole numbers and fractions as required to determine labor costs.
3. Read and interpret blueprints and fabrication time requirements to determine labor costs.
4. Estimate labor costs from simple blueprints.
5. Write a computer program to estimate labor costs based on rate and time.
6. Determine the labor costs for a welded fabrication.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain the procedure for determining labor costs to the whole class.
2. Determine labor costs from blueprint slides.
3. Break the class into teams of students, each team with a different blueprint. Have each team interpret the blueprint and estimate labor costs. Rotate each team through the complete set of prints. Post the results for comparison.
4. Work with students in the computer lab to develop programs for determining labor cost.
5. Work with individual students to help them estimate labor cost for a welded fabrication.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sample sets of simple welding fabrication blueprints and estimate of fabrication time.

2. Transparencies (35 mm slides) of sample blueprints.

3. Micro-computer lab access.

RESOURCES:

Books;
Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS. Delmar Publishers, Albany, NY. pp. 35-39. 1983.

10.0 **COMPETENCY/SKILL:** Estimates project cost and time requirements.

10.6 **TASK:** Determines material cost.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings or blue prints for a part of assembly to be fabricated,

EVALUATION: determines material costs.

STANDARD: The estimation of material cost must be within 10% of the actual cost of production on a sample fabrication.

STUDENT LEARNING EXPERIENCES:

1. Write whole numbers and fractions as required to determine material costs.
2. Add, subtract, multiply and divide whole numbers and fractions as required to determine material costs.
3. Use directories to locate sources of supply.
4. Read and interpret blueprints, lists of materials and cutting lists to determine material costs.
5. Use the telephone to determine material cost and availability.
6. Estimate material costs from simple blueprints.
7. Use a calculator to determine material cost.
8. Write a computer program to estimate material costs.
9. Estimate the materials cost for a welded fabrication.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain the procedure for determining material costs to the whole class.
2. Apply the principles of shop math to determine material costs from blueprints.
3. Break the class into teams of students, each team with a different blueprint. Have each team interpret the blueprint and estimate material costs. Rotate each team through the complete set of prints. Post the results for comparison.

4. Work with students in the computer lab to develop programs for determining material cost.

5. Work with individual students to help them estimate material cost for a welded fabrication.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sample sets of simple welding fabrication blueprints and cutting lists.

2. Transparencies (35 mm slides) of sample blueprints.

3. Micro-computer lab access.

RESOURCES:

Books;
Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS. Delmar Publishers, Albany, NY. pp. 35-39. 1983.

10.0 **COMPETENCY/SKILL:** Estimates project cost and time requirements.

10.7 **TASK:** Prepares a written estimate.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings, materials and cutting lists, estimates of labor and materials costs,

EVALUATION: prepares a written estimate.

STANDARD: The written estimate will include a coverage of materials and labor costs, and be within 10% of the actual cost of production of a welded fabrication.

STUDENT LEARNING EXPERIENCES:

1. Write whole numbers and fractions as required to prepare a written estimate.
2. Add, subtract, multiply and divide whole numbers and fractions as required to prepare a written estimate.
3. Write the narration and notation necessary to prepare a written estimate.
4. Read and interpret blueprints, lists of materials, cutting lists and time/labor estimates as necessary to prepare a written estimate.
5. Use a calculator to prepare a written estimate.
6. Use a dictionary to check the spelling of words in the estimate.
7. Use a microcomputer as a word processor to prepare a written estimate.
8. Prepare a written estimate of the cost of a welded fabrication.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain the procedure for determining material costs to the whole class.
2. Determine material costs from blueprint slides.

3. Break the class into teams of students, each team with a different blueprint. Have each team interpret the blueprint and estimate material costs. Rotate each team through the complete set of prints. Post the results for comparison.

4. Work with students in the computer lab to develop programs for determining material cost.

5. Work with individual students to help them produce a written estimate for a welded fabrication.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sample sets of simple welding fabrication blueprints and cutting lists.

2. Transparencies (35 mm slides) of sample blueprints.

3. Micro-computer lab access.

RESOURCES:

Books;
Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS. Delmar Publishers, Albany, NY. pp. 35-39. 1983.

10.0 **COMPETENCY/SKILL:** Estimates project cost and time requirements.

10.8 **TASK:** Presents a written proposal to a client.

PERFORMANCE OBJECTIVE:

CONDITIONS: Given a set of working drawings, materials and cutting lists, estimates of labor and materials costs, and a written proposal,

EVALUATION: presents a written proposal to a client.

STANDARD: The written proposal will consist of a copy of the working drawing or presentation drawing, a clearly written description of the job, final cost and terms of payment.

STUDENT LEARNING EXPERIENCES:

1. Write a clear description of the project, indicating final cost and terms of payment.
2. Use appropriate language and grammar to participate in a mock exercise to develop presentation skills.
3. Critique an oral presentation of a proposal.
4. Use a microcomputer as a word processor to prepare a written proposal.

SUGGESTED INSTRUCTIONAL TECHNIQUES:

1. Explain the procedure for presenting a written proposal to a prospective customer to the whole class.
2. Act the part of the client for individual student proposal presentations.
3. Work with students in the computer lab to develop written proposals.

INSTRUCTIONAL EQUIPMENT, MATERIALS AND SUPPLIES:

1. Sample sets of simple welding fabrication blueprints, cutting lists.

2. Examples of presentation drawings, written descriptions and cost estimates.

3. Micro-computer lab access.

RESOURCES:

Books;
Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS. Delmar Publishers, Albany, NY. pp. 35-39. 1983.

ANNOTATED BIBLIOGRAPHY

BOOKS

Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. MODERN WELDING. The Goodheart-Willcox Co., Inc. South Holland, IL., 1984.

An excellent, processes oriented, general coverage of the welding field. This book appears to be appropriate for secondary students. Excellent color illustrations in Unit One explain welding process, metal production and fabrication processes.

Bennet, A. E. and Louis J. Siy. BLUE PRINT READING FOR WELDERS, Delmar Publishers, Albany, NY. 1983.

This book offers a complete coverage of blueprint reading for field welders. Included is a sample set of blue prints.

Blodgett, Omer W., DESIGN OF WELDMENTS. The James F. Lincoln Arc Welding Foundation, Cleveland OH., (Classic). 1976.

An excellent, advanced, college level text on welding design for manufacturing and fabrication. A very technical book priced at about half the cost of many texts. This book would be a good instructors reference.

Giachino, Weeks, WELDING SKILLS. American Technical Publishers, Inc., Alsip, IL., 1985.

A well organized, skills oriented, general text. Welding skills are covered with clearly drawn illustrations.

Jeffus, Larry and Harold V. Johnson. WELDING PRINCIPLES AND APPLICATIONS. Delmar Publishers Inc., Albany, NY., 1984.

A good all-round text, with fairly technical written material.

Kearns, W. H., WELDING HANDBOOK. American Welding Society, 550 N.W. LeJune Rd., P.O. Box 357040, Miami FL. 33135. (Classic). 1978.

The authoritative source on welding processes, covers all major and minor welding processes in great detail. This book should be included in every welding library.

Kennedy, Gower A. WELDING TECHNOLOGY. Glencoe Publishing Co., Encino, CA. 1982.

A good general text, fairly technical text material.

O'Brien, R.L. PLASMA ARC METAL WORKING PROCESSES. American Welding Society, 550 N.W. LeJune Rd., P.O. Box 357040, Miami FL. 33135. (Classic). 1967.

A standard reference text.

Sacks, Raymond WELDING PRINCIPLES & PRACTICES. Glencoe Publishing Co., Encino, CA., 1984.

A technical skills and process oriented text that would work well for a college text.

Schell Frank R., and Bill J. Matlock. PRACTICAL PROBLEMS IN MATHEMATICS FOR WELDERS. Delmar Publishers Inc., Albany, NY. 1982.

This would be a good supplementary text for welding classes. A good set of practical math applications.

Smith, Dave. WELDING SKILLS AND TECHNOLOGY. Gregg Division, McGraw Hill Book Co. Novato, CA. 1984.

A good, technically oriented text dealing with theory and skill development. This book makes extensive use of written text.

ARC WELDED PROJECTS, Volume II Published by The James F. Lincoln Arc Welding Foundation, Cleveland, OH. (Classic). 1978.

An excellent source of project ideas. Includes text descriptions, specifications, drawings and details.

BRAZING MANUAL. American Welding Society, 550 N.W. LeJune Rd., P.O. Box 357040, Miami FL. 33135. (Classic). 1976.

The American National Standard for brazing processes.

PROCEDURE HAND BOOK OF ARC WELDING, The Lincoln Electric Company. Cleveland, OH. (Classic). 1973.

This book covers a wide variety of welding processes and would provide a good source of trouble shooting information for arc welding.

BOOKLETS:

OPERATORS MANUAL FOR OXYFUEL GAS CUTTING. American Welding Society, 550 N.W. LeJune Rd., P.O. Box 357040, Miami FL. 33135. (Classic). 1978.

The American National Standard for oxyfuel cutting processes.

RECOMMENDED PRACTICES FOR AIR CARBON-ARC GOUGING AND CUTTING. 1982.

The American National Standard for air carbon-arc processes.

VIDEO:

ARC WELDING SAFETY. VHS Abraxas Basic Courseware, Eugene, OR.

Arc welding safety instruction.

LAP WELDS, VHS Career Aids Inc. 20417 Nordhoff St., Dept. MM, Chatsworth, CA. 91311.

Instructional video for skill development in lap welding processes.

NOISE? YOU'RE IN CONTROL, VHS Agency for Instructional Technology, Box A, Bloomington, IN. 47402.

This video provides an excellent coverage of the dangers of workplace noise protective devices.

SHIELDED METAL ARC PIPE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton WI., 1985.

A complete welding curriculum consisting of video and print instructional material.

SHIELDED METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton WI., 1985.

A complete welding curriculum consisting of video and print instructional material.

SHIELDED METAL ARC PIPE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton WI., 1985.

A complete welding curriculum consisting of video and print instructional material.

GAS METAL ARC PLATE WELDING, Miller Module Method (Video training system) VHS, Miller Electric Mfg. Co., Appleton WI., 1985.

A complete welding curriculum consisting of video and print instructional material.

SQUARE BUTT JOINT FILLER ROD, VHS Career Aids Inc., 20417 Nordhoff St., Dept. MM. Chatsworth CA. 91311.

Instructional video for skill development in butt welding processes.

OXYACETYLENE WELDING, VHS Career Aids Inc., 20417 Nordhoff St., Chatsworth CA. 91311.

Basic video instruction for oxyacetylene welding processes.

OXYACETYLENE WELDING SAFETY Parts 1 and 2, VHS (Safety) Abraxas Basic Courseware, Eugene OR.

Basic oxyacetylene safety video instruction.

OXYACETYLENE EQUIPMENT SET-UP AND SAFETY, VHS Career Aids Inc., 20417 Nordhoff St., Dept. MM. Chatsworth, CA. 91311.

Basic video instruction for oxyacetylene welding processes.

SHIELDED METAL ARC - PLATE WELDING: PART 1, VHS Career Aids Inc., 20417 Nordhoff St., Dept. MM. Chatsworth CA. 91311.

Basic video instruction for shielded metal arc (SMAW) welding processes.

SHIELDED METAL ARC-PIPE WELDING, VHS Career Aids Inc., 20417 Nordhoff St., Dept. MM. Chatsworth CA. 91311.

Basic video instruction for shielded metal arc (SMAW) pipe welding processes.

SUPERWELDER, VHS Agency for Instructional Technology, Box A, Bloomington, IN. 47402.

This video provides an excellent introduction to welding safety.

THE FUTURE IS IN YOUR HANDS, VHS Agency for Instructional Technology, Box A, Bloomington, IN. 47402.

This video provides a basis for thought and discussion on the topic of welding safety.

THE OTHER HALF OF THE SAFETY TEAM, VHS Agency for Instructional Technology, Box A, Bloomington, IN. 47402.

This video provides an introduction to teamwork and consideration for others in the welding lab.

WELDING, MAKING IT HAPPEN, VHS American Welding Society, 550 N.W. LeJune Rd., P.O. Box 357040, Miami FL. 33135. 1987.

This video provides a good general coverage of welding and new developments in the field.

COMPUTER PROGRAMS:

ARC WELDING. For Apple IIe, TRS 80 Mod 3 or 4, IBM PC. Career Aids Inc., 20417 Nordhoff St., Dept. MM., Chatsworth CA. 91311. 1987.

Instructional program providing an introduction to arc welding.

WELDING ELECTRODES IDENTIFICATION. For Apple IIe, TRS 80 Mod 3 or 4, IBM PC. Career Aids Inc., 20417 Nordhoff St., Dept. MM. Chatsworth CA. 91311. 1987.

Instructional program designed to help select electrodes.

WELDING EQUIPMENT SAFETY AND OPERATIONS. For Apple IIe, TRS 80 Mocel 3 or 4 and IBM PC. Career Aids Inc., 20417 Nordhoff St., Dept. MM, Chatsworth, CA. 91311. 1987.

CHARTS:

FILLER METAL COMPARISON CHARTS, The American Welding Society, 550 N.W. LeJune Rd., P.O. Box 357040, Miami FL. 33135. 1986.

This is the American National Standard for filler rod characteristics, types and applications.

WORKBOOKS:

SHIELDED METAL-ARC PIPE WELDING (DOWNHILL), Hobart School of Welding Technology. (Classic). 1969.

This is one of a series of workbooks that provide an excellent source of basic information and instruction.

SHIELDED METAL-ARC PIPE WELDING (DOWNHILL), Hobart School of Welding Technology. (Classic). 1969.

This is one of a series of workbooks that provide an excellent source of basic information and instruction.

SHIELDED METAL-ARC PIPE WELDING (UPHILL), Hobart School of Welding Technology. (Classic). 1968.

This is one of a series of workbooks that provide an excellent source of basic information and instruction.